RELIANCE ELECTRIC

LiquiFlo AC Power Modules Hardware Reference, Installation, and Troubleshooting Version 6.4

Instruction Manual D2-3411-7

Rockwell Automation

The information in this manual is subject to change without notice.

Throughout this manual, the following notes are used to alert you to safety considerations:

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

Important: Identifies information that is critical for successful application and understanding of the product.

The thick black bar shown on the outside margin of this page will be used throughout this instruction manual to signify new or revised text or figures.

ATTENTION: Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

ATTENTION: Do not install or remove modification kits with power applied to the drive. Disconnect and lock out incoming power before attempting such installation or removal. Failure to observe this precaution could result in severe bodily injury or loss of life.

ATTENTION: DC bus capacitors retain hazardous voltages after input power has been disconnected. After disconnecting input power, wait five (5) minutes for the DC bus capacitors to discharge and then check the voltage with a voltmeter to ensure the DC bus capacitors are discharged before touching any internal components. Failure to observe this precaution could result in severe bodily injury or loss of life.

ATTENTION: The drive is capable of operating at and maintaining zero speed. The user is responsible for assuring safe conditions for operating personnel by providing suitable guards, audible or visual alarms, or other devices to indicate that the drive is operating or may operate at or near zero speed. Failure to observe this precaution could result in severe bodily injury or loss of life.

ATTENTION: The user must provide an external, hardwired emergency stop circuit outside of the drive circuitry. This circuit must disable the system in case of improper operation. Uncontrolled machine operation may result if this procedure is not followed. Failure to observe this precaution could result in bodily injury.

ATTENTION: The user is responsible for conforming with all applicable local, national, and international codes. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

ATTENTION: The drive contains ESD- (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing, or repairing the drive. Erratic machine operation and damage to, or destruction of, equipment can result if this procedure is not followed. Failure to observe this precaution can result in bodily injury.

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CHAPTER 1
Introduction

This instruction manual describes the LiquiFlo™ drive's Power Module and regulator hardware. It does not cover the LiquiFlo software. For software information, refer to the LiquiFlo AC General Purpose (V/Hz) and Vector Duty Drive Software Start-Up and Reference Manual (D2-3410).

This manual is intended for qualified electrical and plumbing personnel.

LiquiFlo drives will typically be referenced by frame size. If additional clarity is required, drive model numbers wil also be included.

1.1 Related Publications

Refer to the following related publications as necessary for more information:

- D2-3410 - LiquiFlo AC General Purpose (V/Hz) and Vector Duty Drive Software Start-Up and Reference Manual
- D2-3305 - Motor Encoder Cable Kit
- D2-3348 - Control and Configuration Software (CS3000)
- D2-3341 - Remote Meter Interface Board
- D2-3342 - Operator Interface Module
- D2-3449 - LiquiFlo AC Drive Panel Mount Kit

1.2 Getting Assistance from Reliance Electric

If you have any questions or problems with the products described in this instruction manual, contact your local Reliance Electric sales office. For technical assistance, call 1-864-284-5444.

CHAPTER 2

About the Drive

This chapter describes how to identify the drive using the model number matrix and shows the major drive components.

The LiquiFlo AC drive is a PWM (pulse-width-modulated) liquid-cooled drive that provides vector and general purpose regulation for a wide range of applications.

Using vector regulation, the drive can provide high dynamic response, maintain full rated motor torque to zero speed, and precisely control motor speed in both directions. The drive can provide this functionality either with encoder feedback (flux vector control or FVC) or without (sensorless vector control or SVC).

Using general purpose (volts/hertz or V/Hz) regulation, the drive is suited for a broad range of applications requiring adjustable speed control of motors.

2.1 Identifying the Drive by Model Number

Each LiquiFlo AC drive can be identified by its model number. See figure 2.1. This number appears on the shipping label and on the drive's nameplate. The drive's model number includes the Power Module and the regulator version. Drive power ratings are provided in table 2.1.

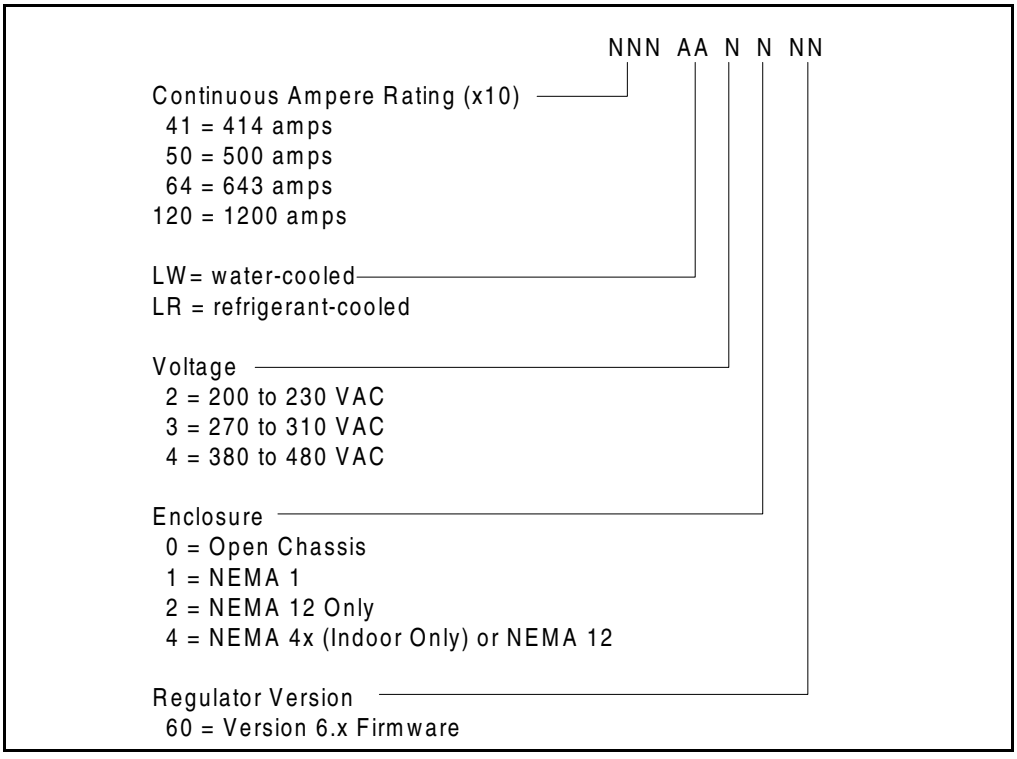

NNN AA N N NN
Continuous Ampere Rating (x10)
41 = 414 amps
50 = 500 amps
64 = 643 amps
120 = 1200 amps
LW= water-cooled
LR = refrigerant-cooled
Voltage
2 = 200 to 230 VAC
3 = 270 to 310 VAC
4 = 380 to 480 VAC
Enclosure
0 = Open Chassis
1 = NEMA 1
2 = NEMA 12 Only
4 = NEMA 4x (Indoor Only) or NEMA 12
Regulator Version
60 = Version 6.x Firmware

Figure 2.1 – Identifying the Drive Model Number

Table 2.1 – Power and Enclosure Ratings

Model Number	Frame Size and Selected Regulation*	Enclosure Rating	Input Power (KVA)	Input Current (Amps)	Output Current at 2 kHz** (Amps)	Full Load Power Loss Watts Fluid / Air
41L4060 41LR4060	B-Frame V/Hz or Vector	Open-Chassis Style	344	414	414	4600 / 1100
50LW4060 50LR4060	C-Frame V/Hz or Vector	Open-Chassis Style	398	500	500	5500 / 1500
64LW4060 64LR4060	C-Frame V/Hz or Vector	Open-Chassis Style	512	643	643	7000 / 2000
120L4060	D-Frame V/Hz or Vector	Open-Chassis Style	956	1200	1200	11700/4000

* With V/Hz regulation, 110% continuous output current capability. With vector regulation, 150% output current capability for 5 sec.
**Note that LiquiFlo drives are rated for use with water at specified temperatures and pressures as the coolant. Some coolant fluids may allow an increased output rating while others may require the output to be derated. The LiquiFlo drive is also capable of running at 4 kHz or 8 kHz. Contact Reliance Electric for ratings.

2.2 Enclosure Ratings

LiquiFlo drives have the following enclosure rating:

- Open-Chassis Style: Intended to be installed in an enclosure.

LiquiFlo drives must be placed in an enclosure.

2.3 B-Frame LiquiFlo Drive Component Locations

The B-Frame LiquiFlo drives have the following main components. The numbered items listed below provided correspond to the numbers used in figure 2.2. Replacement parts are listed in chapter 9.

1. Bus Bars (3) (AC Output)
2. Bus Bars (6) (AC Input)
3. IGBT Modules
4. Output Laminate
5. Capacitors
6. RMI Board
7. Casting
8. Membrane Switch Keypad
9. Coolant Lines - (a) Inlet, (b) Outlet
10. Regulator Board
11. Power Module Control (PCB)
12. Current Feedback Devices (3)

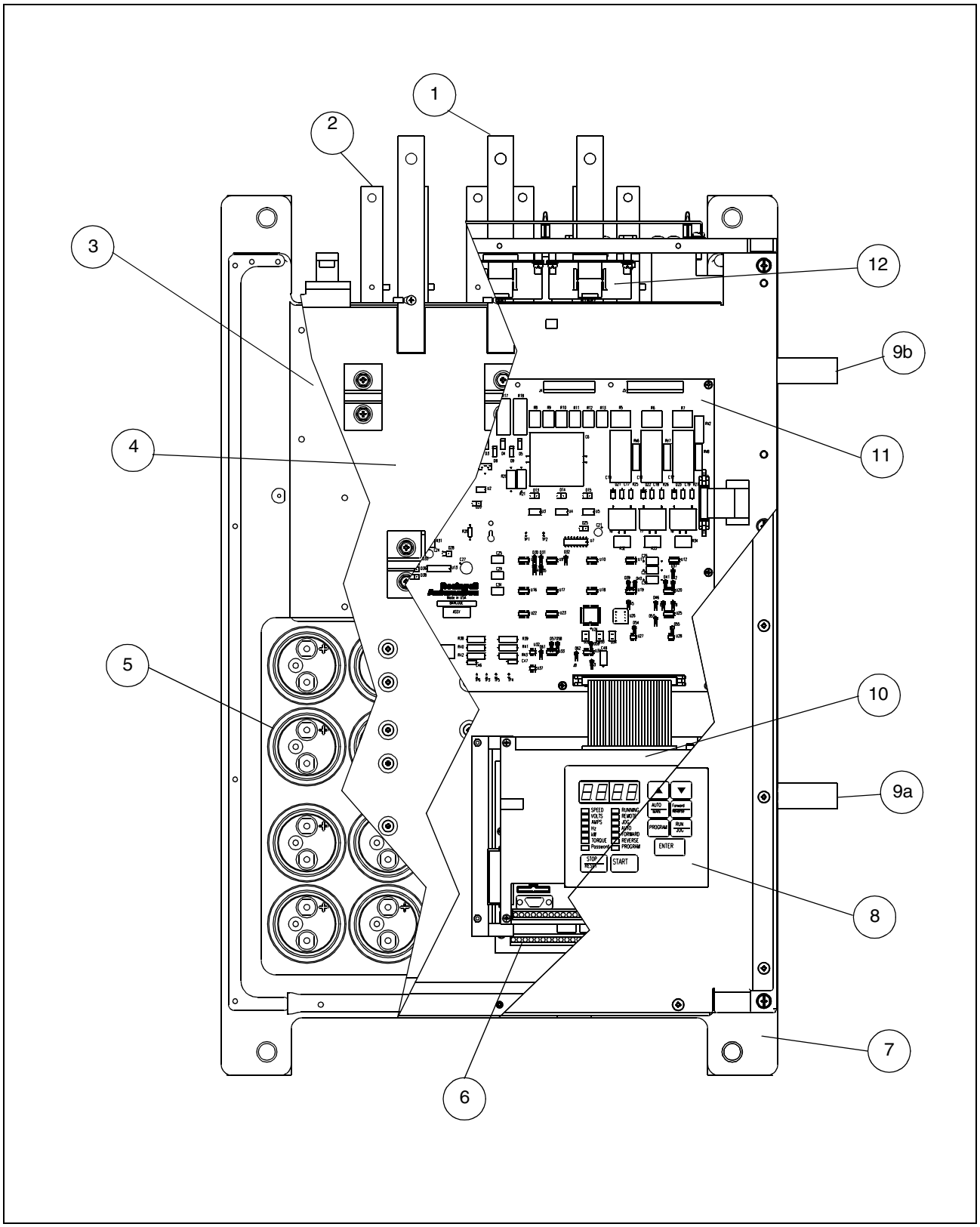


Figure 2.2 – B-Frame LiquiFlo Drive Component Locations

2.4 C-Frame LiquiFlo Drive Component Locations

The C-Frame LiquiFlo drives have the following main components. The numbered items listed below provided correspond to the numbers used in figure 2.3. Replacement parts are listed in chapter 9.

1. Bus Bars (AC Input)
2. SCR Bridge (AC to DC Converter)
3. Power Module Adapter Printed Circuit Board (PCB)
4. Power Interface Harness
5. Bus Bars (AC Output)
6. LEM InterfaceHarness
7. DC Bus Control PCB
8. Gate Driver PCB -Low Side
9. DC Bus Laminate Assembly
10. Output Current Feedback Devices
11. IGBT Modules
12. Chillplate (Heatsink)
13. Capacitors
14. Drive Baseplate
15. Reactor (Not Shown)
16. Discharge Resistors (Not Shown)
17. Control Panel Assembly
18. Bus Control - PMA Harness
19. Bus Control - Gate Drive Harness
20. Gate Driver PCB- High Side (Not Shown)
21. Membrane Switch Keyboard/Bracket
22. Regulator PCB
23. Option Board (Optional)
24. Coolant Lines - (Not Shown)

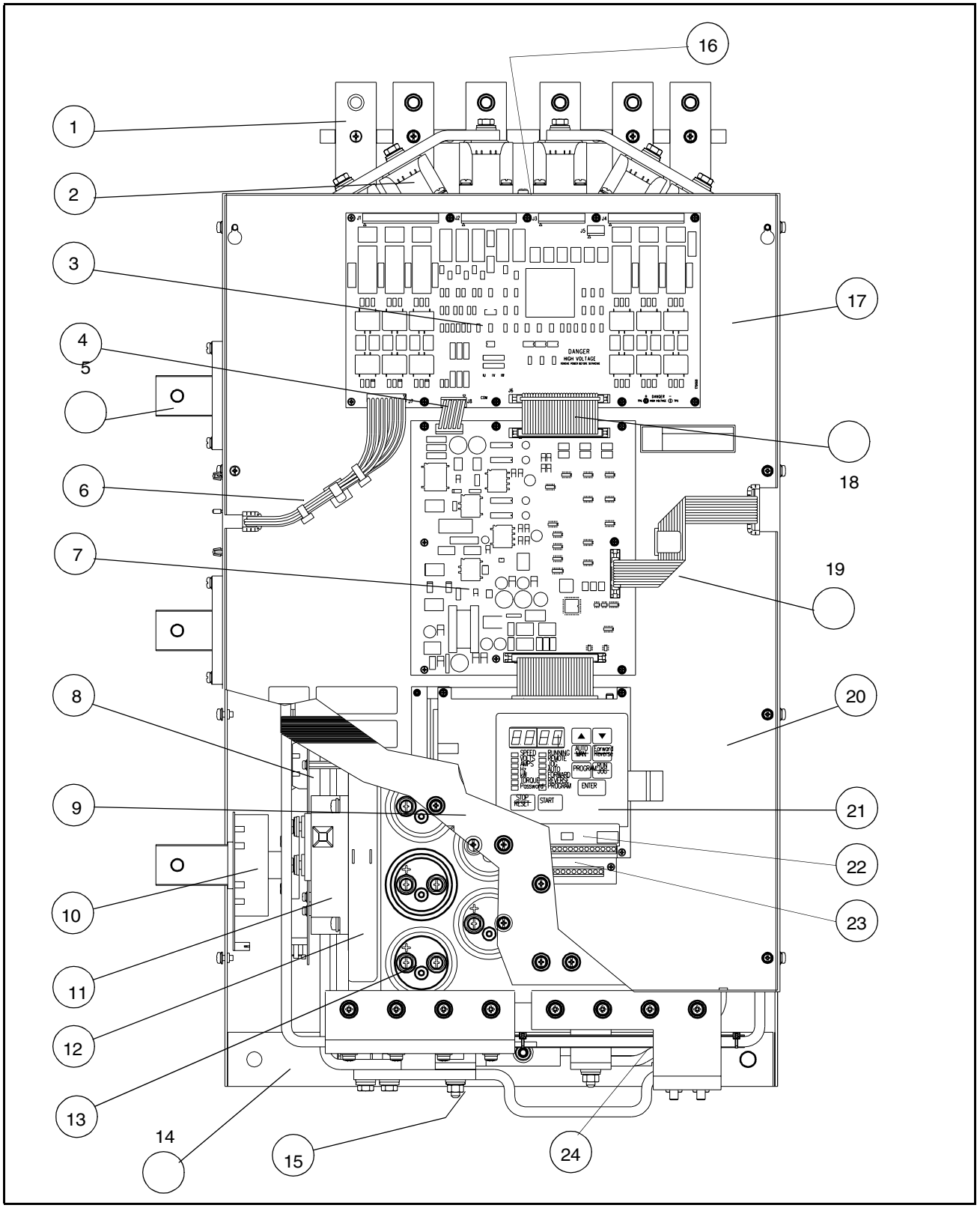


Figure 2.3 – C-Frame LiquiFlo Drive Component Locations

2.5 D-Frame LiquiFlo Drive Component Locations

The D-Frame LiquiFlo drives have the following main components. The numbered items listed below provided correspond to the numbers used in figure 2.4. Replacement parts are listed in chapter 9.

1. Chillplate Harness
2. Bus Bars (AC Input)
3. Bus Bars (AC Output)
4. Power Module Control PCB
5. Membrane Switch Keypad
6. Regulator PCB
7. RMI Option PCB
8. Current Feedback Devices
9. Gate Driver PCB
10. Coolant Connection (Outlet)
11. IGBT Module
12. Capacitors
13. Coolant Connection (Inlet)
14. Output Laminate

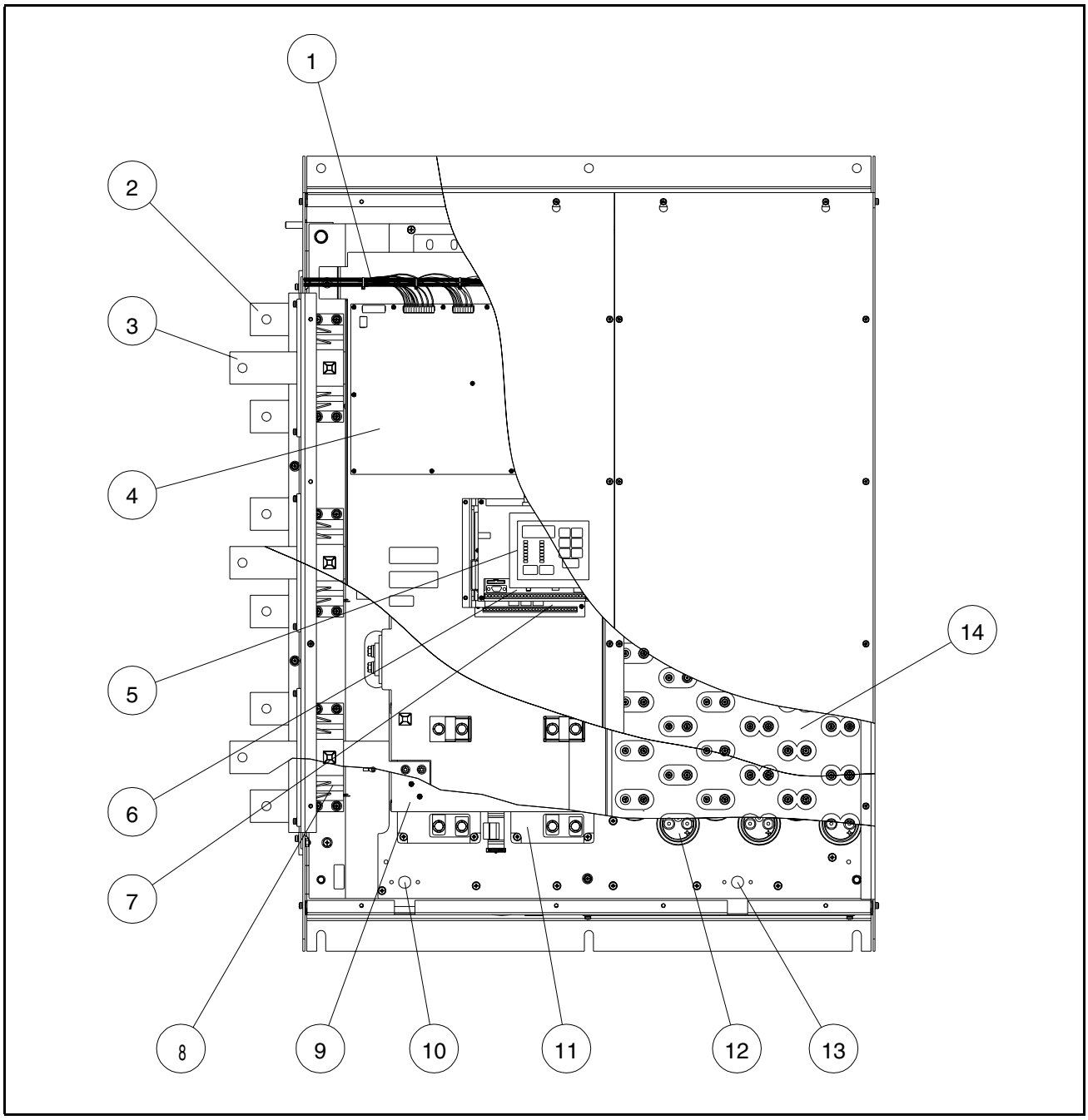


Figure 2.4 – D-Frame LiquiFlo Drive Component Locations

2.6 Regulator Board Description

LiquiFlo drive regulation is performed by a microprocessor on the Regulator board. See figure 2.5. Drive operation is adjusted by the parameters entered through the keypad. The Regulator board accepts power circuit feedback signals and an external speed reference signal, as well as data from an encoder that is attached to the motor when set up for FVC regulation. The Regulator board provides:

- PWM gating signals to the IGBT power devices
  Based on the output of the control loop, the regulator sends PWM gating signals to isolated drivers on the Gate Driver board. These drivers switch the Insulated Gate Bi-polar Transistors (IGBTs), producing a waveform that corresponds to the voltage and frequency outputs of the inner V/Hz, FVC, or SVC regulators. The IGBTs can be switched at either a 2, 4, or 8 kHz carrier frequency.
- Form A and B contacts for drive status indicators
  The Form A and B contacts are under control of the user via programmable parameters. A Form A or B transition can indicate drive status. The contacts are rated for 5 amps resistive load at 250 VAC/30 VDC and are made available through the terminal strip.
- Display data for a four-character display and fourteen indicator LEDs
  For a description of the keypad/display refer to section 2.6.6. For operational instructions, see the LiquiFlo Software Reference manual (D2-3410).
- An analog output
  The analog output is a scaled voltage (0-10 VDC) or current (4-20 mA) signal proportional to either motor speed (RPM), motor torque, or current (%TORQUE). The current signal selection (via jumper J17) requires a power supply for operation. The power can be sourced from the encoder terminals (4 and 9) or from an external 15 V power supply. See table 7.1, terminals 10 and 11, for more information. The analog output signal is available through the terminal strip.

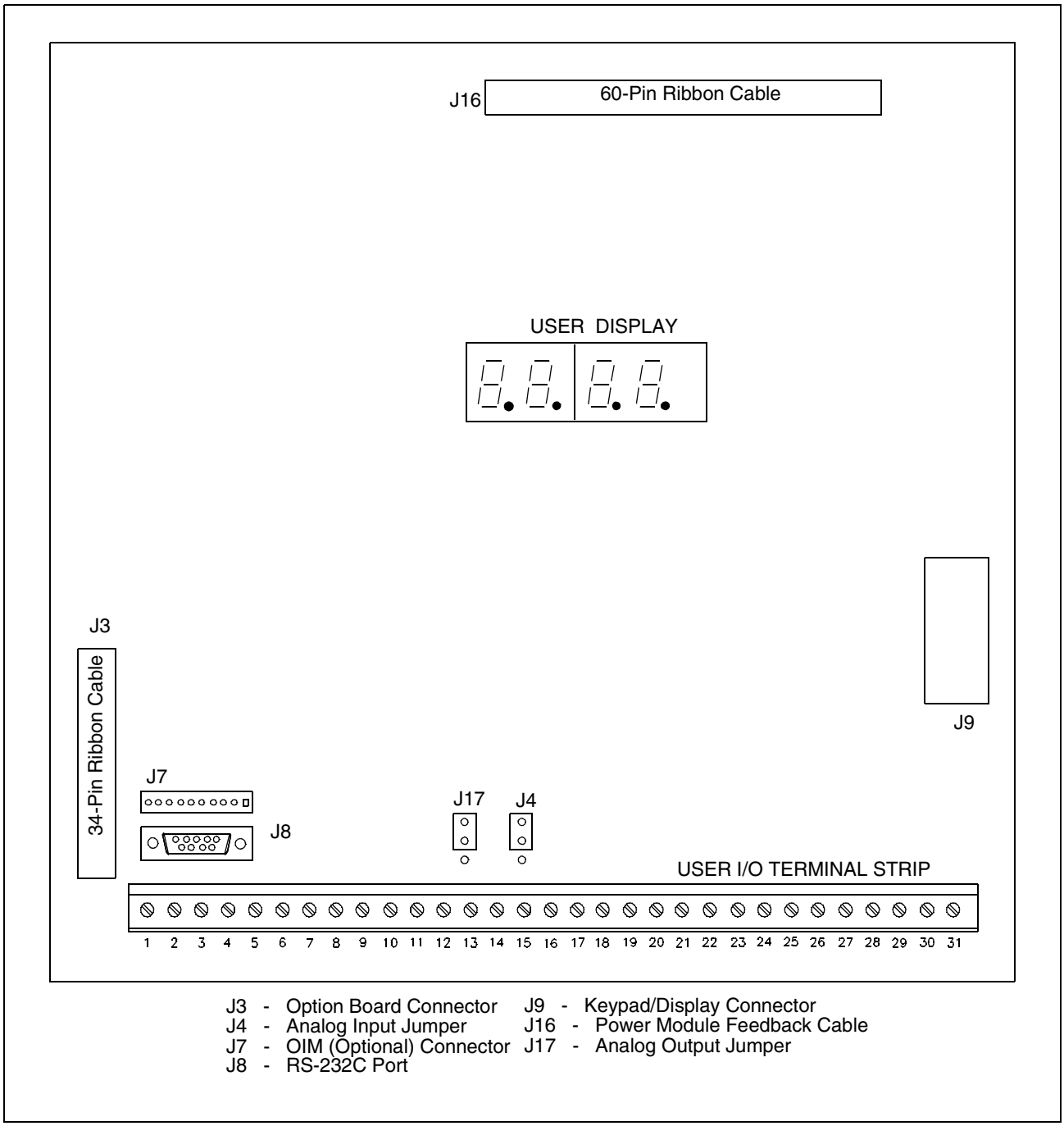

J16
60-Pin Ribbon Cable
USER DISPLAY
J3
34-Pin Ribbon Cable
J9
J7
J8
J17
J4
USER I/O TERMINAL STRIP
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
J3 - Option Board Connector
J4 - Analog Input Jumper
J7 - OIM (Optional) Connector
J8 - RS-232C Port
J9 - Keypad/Display Connector
J16 - Power Module Feedback Cable
J17 - Analog Output Jumper

Figure 2.5 – LiquiFlo Regulator Board Component Locations

2.6.1 Jumper Locations and Settings

Jumpers J4 and J17 on the Regulator board are factory-set for voltage in and voltage out signals. Refer to figure 2.5 for their locations on the Regulator board. If you need to change the jumpers' settings, use the following procedures.

ATTENTION: Do not alter the setting of any jumper not described in this instruction manual. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

2.6.1.1 Setting the Analog Input Speed Reference Jumper (J4)

Jumper J4 is the analog speed/torque (U.000) reference jumper. This jumper selects either +/- 10 VDC or 0-20 mA input. Parameters P.009, P.010, and P.011 are used in conjunction with the jumper.

Note that if the position of jumper J4 is changed after the parameters are programmed, the software will not recognize that the input reference or polarity has been changed. Be sure to verify that parameters P.009, P.010, and P.011 are correct before starting the drive. Refer to the LiquiFlo Software Start-Up and Reference manual for more information.

Use the following procedure to set jumper J4:

ATTENTION: DC bus capacitors retain hazardous voltages after input power has been disconnected. After disconnecting input power, wait five (5) minutes for the DC bus capacitors to discharge and then check the voltage with a voltmeter to ensure the DC bus capacitors are discharged before touching any internal components. Failure to observe this precaution could result in severe bodily injury or loss of life.

Step 1. Turn off input power to the drive and wait five minutes.

Step 2. Open the door of the enclosure.

Step 3. Verify that the DC bus voltage is zero by following the procedure in section 9.3.

Step 4. Locate jumper J4 on the Regulator board. Refer to figure 2.5.

Step 5. Locate pin 1 on jumper J4. Move the jumper to the desired setting as shown in figure 2.6.

Step 6. Close the door of the enclosure.

Step 7. Reapply input power.

Step 8. Verify that Terminal Strip Analog Input Offset (P.009), Terminal Strip Analog Input Gain (P.010), and Terminal Strip Analog Input Configure (P.011) are correctly set. Note that the jumper settings must match the software settings; otherwise, the reference value may differ from what is expected. Refer to the LiquiFlo Software Start-Up and Reference manual for more information.

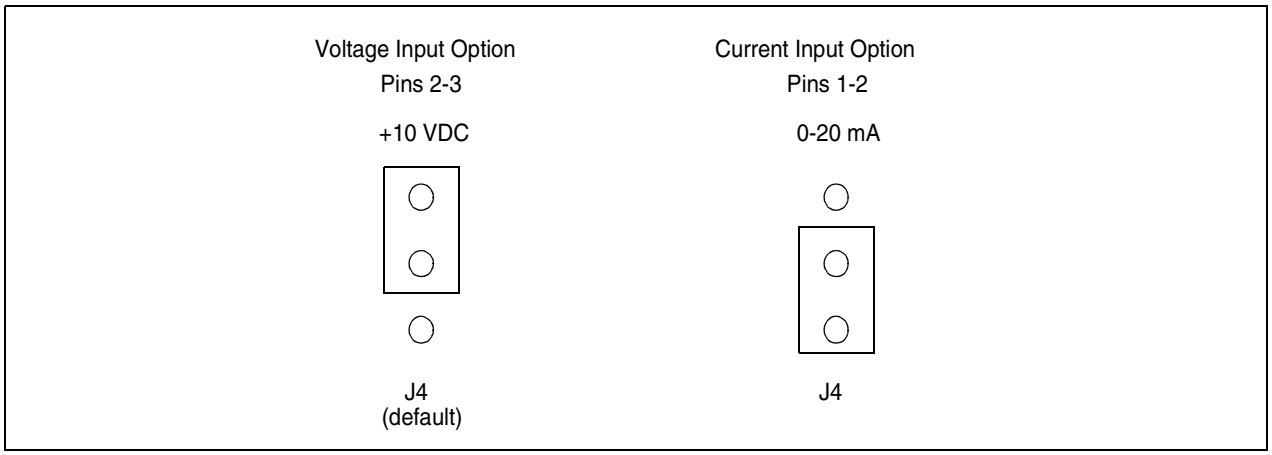


Figure 2.6 – Jumper J4 Settings for Analog Input Speed Reference

2.6.1.2 Setting the Analog Output Jumper (J17)

Jumper J17 is the analog output jumper. This jumper selects either a 0-10 VDC or 4-20 mA scaled signal output that is programmable to be proportional to either speed or torque using parameter P.012. Refer to the LiquiFlo Software Reference manual for more information about this parameter.

The jumper only selects a 0-10 VDC source voltage or 4-20 mA sink current to represent speed or torque. Note that the 4-20 mA current selection requires a power supply for operation as shown in table 7.8, terminals 10 and 11.

Use the following procedure to set jumper J17:

ATTENTION: DC bus capacitors retain hazardous voltages after input power has been disconnected. After disconnecting input power, wait five (5) minutes for the DC bus capacitors to discharge and then check the voltage with a voltmeter to ensure the DC bus capacitors are discharged before touching any internal components. Failure to observe this precaution could result in severe bodily injury or loss of life.

Step 1. Turn off input power to the drive and wait five minutes.

Step 2. Open the door of the enclosure.

Step 3. Verify that the DC bus voltage is zero by following the procedure in section 9.3.

Step 4. Locate jumper J17 on the Regulator board. Refer to figure 2.5.

Step 5. Locate pin 1 on jumper J17. Move the jumper to the desired setting as shown in figure 2.7.

Step 6. Close the door of the enclosure.

Step 7. Reapply input power.

Step 8. Verify that parameter P.012 is set correctly for either speed or current.

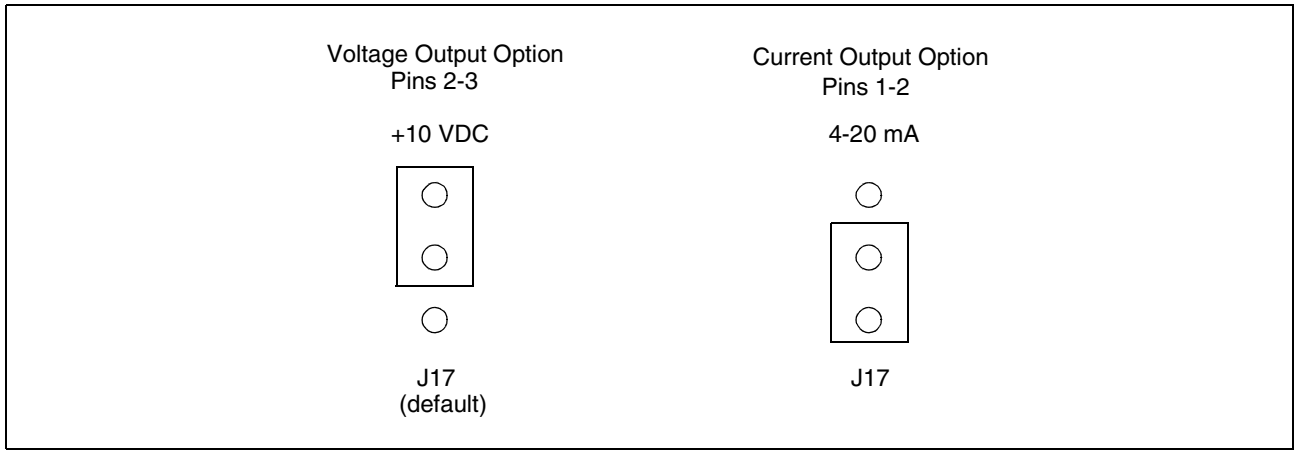


Figure 2.7 – Jumper J17 Settings for Analog Outputs

2.6.2 Wiring the Regulator Board Terminal Strip

The terminal strip on the Regulator board provides terminals for connecting customer I/O devices. See figures 2.5 and 2.8. The following terminals are provided:

- Terminals 1-3: RS-232 connections
- Terminals 4-9: encoder connections
- Terminals 10-11: analog output connections
- Terminals 12-15: analog speed/torque reference connections
- Terminals 16-25: 24 VDC digital input connections
- Terminal 26: no connection
- Terminal 27: 24 VDC common
- Terminals 28-31: status relay connections

See chapter 7 for a complete description of, and how to wire, all of the signals available through the Regulator board terminal strip.

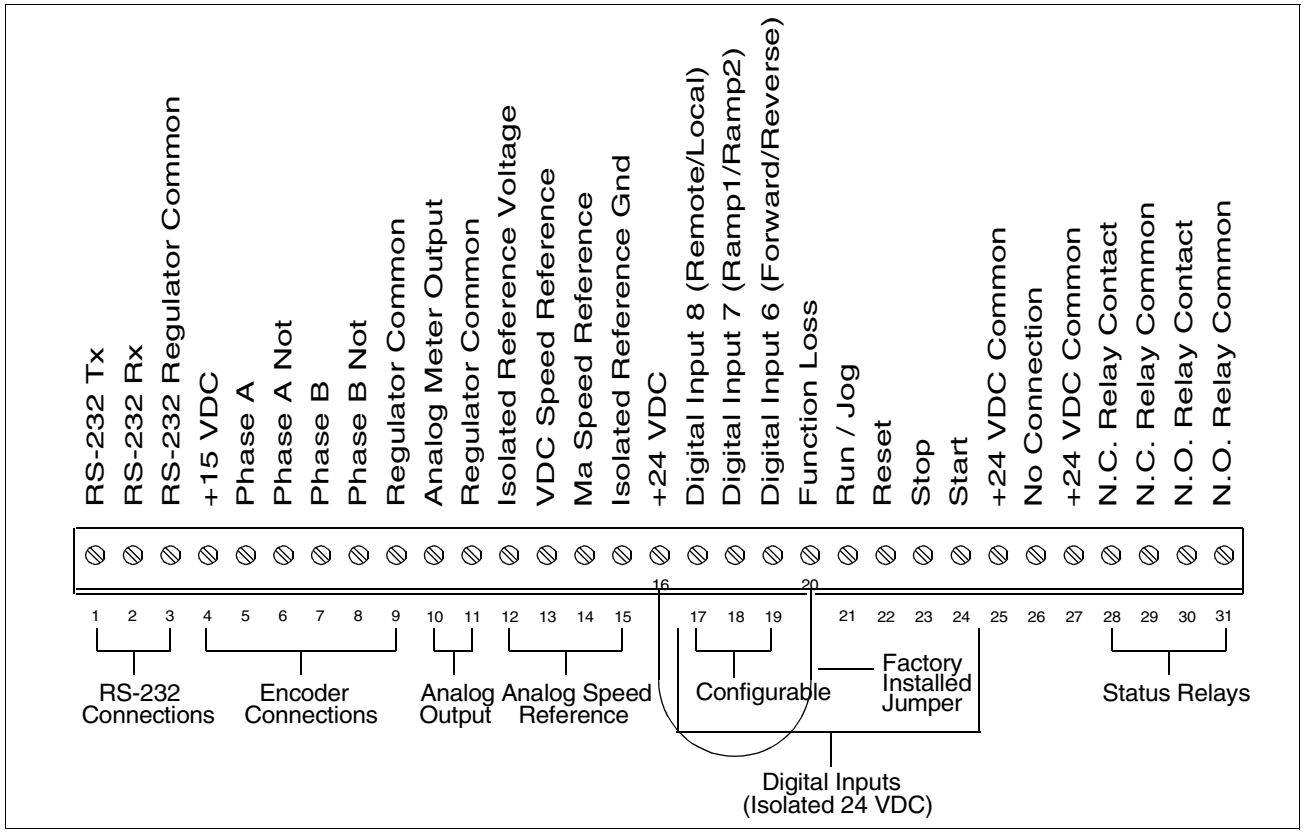


Figure 2.8 – Typical Regulator Board Terminal Strip Connections

2.6.3 RS-232 Communication Port

The Regulator board contains a 9-pin D-shell RS-232 communication port (J8). This port provides RS-232 communication between the LiquiFlo drive and a personal computer running the Control and Configuration (CS3000) software. See figure 2.5. Refer to instruction manual D2-3348 for more information about the CS3000 software.

2.6.4 RMI Board Connector

The flat-ribbon cable connector (J3) on the left side of the Regulator board is a parallel bus connection port that is used on LiquiFlo drives for the Remote Meter Interface (RMI) board.

The RMI board provides an extended set of terminal strip inputs and outputs for the LiquiFlo drive. When the drive control source is the terminal strip (P.000 = rE), the RMI board can be used to provide additional speed reference selections. The RMI board also provides an outer PI regulator that is used to adjust trim. An optional adjustable torque (vector) or current (V/Hz) limit is available using the RMI board's analog or frequency input. See section 2.7 for a more detailed description of the RMI board. Refer to section 7.4 for a detailed description of the RMI terminal strip signals, and how to wire the RMI board.

The J3 connector can also be used to provide a means of attaching optional boards such as the DeviceNet™ Option board, the AutoMax™ Network Option board, or similar boards to the LiquiFlo drive. Note that you must first remove the RMI board before a communication board can be added to the LiquiFlo drive.

Refer to the appropriate board instruction manual for more information. Refer to section 2.8 of this manual for more information on optional drive kits.

2.6.5 Operator Interface Module Connector

Flat-ribbon connector J7 provides a means of attaching the optional Operator Interface Module (OIM). The OIM is available for use as a remote keypad for the LiquiFlo drive. Refer to the OIM instruction manual (D2-3342) for more information.

2.6.6 Keypad/Display

The front panel keypad/display is used to program and operate the LiquiFlo drive. See figure 2.9. The four-character display is used to indicate drive parameters, parameter values, and fault codes. The fourteen single LEDs indicate drive status and mode, as well as identifying drive outputs whose values are displayed on the four-character display.

Refer to the LiquiFlo Software Start-Up and Reference manual for more information.

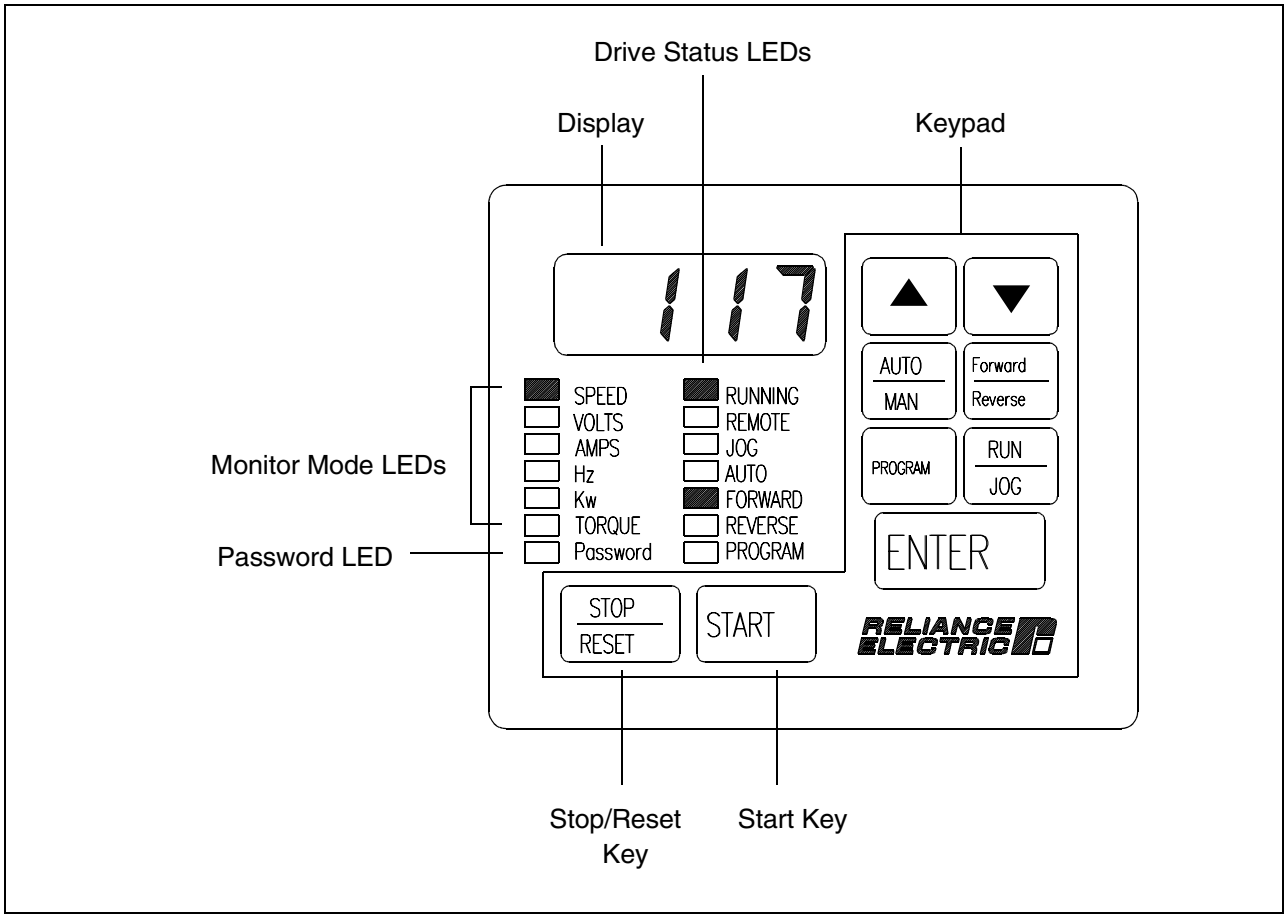


Figure 2.9 – Keypad/Display

2.7 RMI Board Description

The following signals are available at the RMI board terminal strip. Refer to figure 2.10 for terminal identification. For a detailed description of the RMI board signals, refer to section 7.4.

2.7.1 Digital Inputs

Four 24 volt DC digital inputs provide additional speed reference options. The inputs are active high. A 24 VDC supply is provided by the RMI board for use with the digital inputs. The supply is short circuit- and overvoltage-protected.

2.7.2 Digital Outputs

Four 24 volt digital outputs are turned on and off as a result of data comparisons in the drive. All digital outputs are source-driven (active high with common ground) and short circuit-protected. Each output has an adjustable time delay that can be programmed as an on-delay or an off-delay. An option to select an external 24 volt supply for increased current capability at the outputs is jumper-selectable.

2.7.3 Relay Outputs

Three relay outputs can be turned on and off as a result of data comparisons in the drive. Each output has an adjustable time delay that can be programmed as an on-delay or an off-delay. All contacts are rated at 2A, 24VDC or 250VA, 120VAC.

2.7.4 Analog Input

The analog input is based on a 10-bit analog-to-digital (A/D) converter and is jumper-selected between 0 to 10 volts or 0 to 20 mA. Separate connection terminals are provided for voltage input and current input. The inputs are overvoltage-protected. Offset and gain are computed by software.

2.7.5 Analog Outputs

Three analog output channels can be configured. The outputs are short circuit protected. The output value is modulated over four 1 msec scans to provide 10-bit data resolution.

2.7.6 Frequency Input

The frequency input operates from 0 to 200 kHz, 15 VDC. The input is single-ended and uses the same common as the analog input.

2.7.7 Wiring the RMI Board Terminal Strip

ATTENTION: You are responsible for conforming with all applicable local, national, and international codes. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Refer to figure 2.10 for the signal and control I/O terminal connections on the RMI board. terminal strip connections and related parameters. Refer to section 7.4 for descriptions of, and how to wire, all RMI board terminal strip connections.

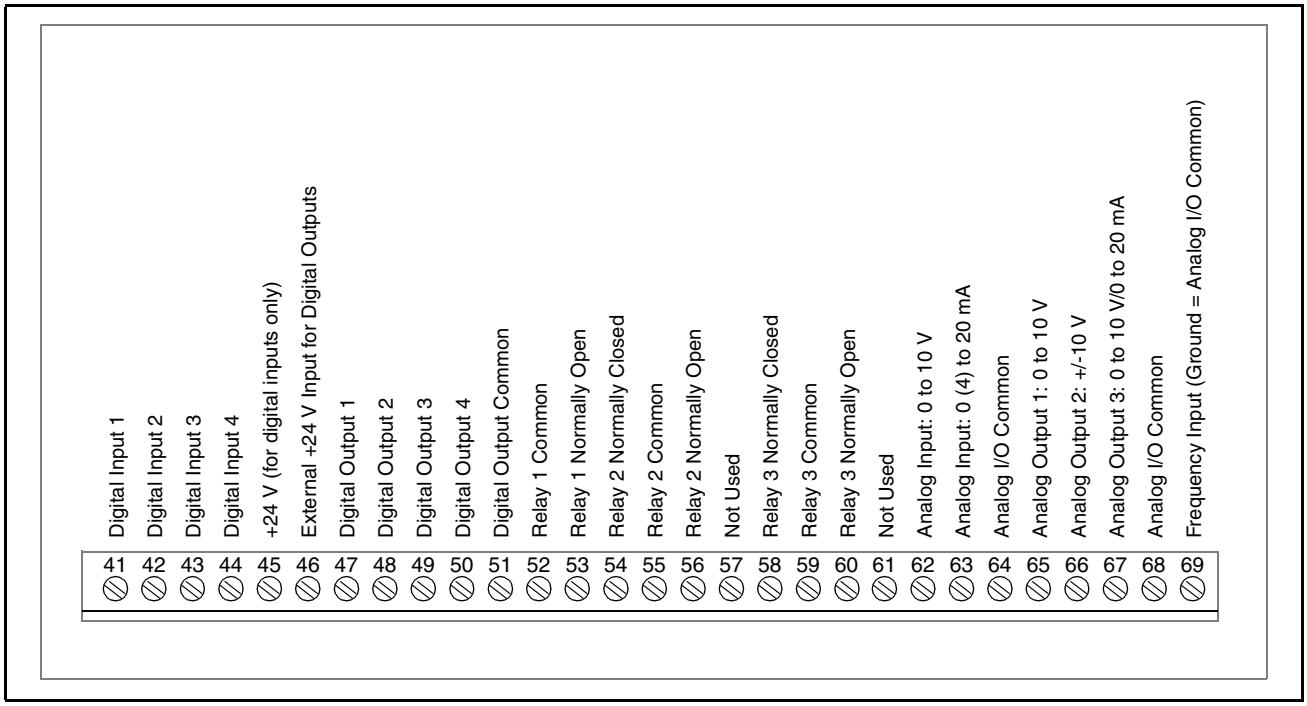

41 Digital Input 1
42 Digital Input 2
43 Digital Input 3
44 Digital Input 4
45 +24 V (for digital inputs only)
46 External +24 V Input for Digital Outputs
47 Digital Output 1
48 Digital Output 2
49 Digital Output 3
50 Digital Output 4
51 Digital Output Common
52 Relay 1 Common
53 Relay 1 Normally Open
54 Relay 2 Normally Closed
55 Relay 2 Common
56 Relay 2 Normally Open
57 Not Used
58 Relay 3 Normally Closed
59 Relay 3 Common
60 Relay 3 Normally Open
61 Not Used
62 Analog Input: 0 to 10 V
63 Analog Input: 0 (4) to 20 mA
64 Analog I/O Common
65 Analog Output 1: 0 to 10 V
66 Analog Output 2: +/-10 V
67 Analog Output 3: 0 to 10 V/0 to 20 mA
68 Analog I/O Common
69 Frequency Input (Ground = Analog I/O Common)

Figure 2.10 – Terminal Connections on the RMI Board

2.8 Optional Equipment

Table 2.2 lists standard available LiquiFlo kits and options.

Table 2.2 – Available Kits and Options

Description	Model Number	Instruction Manual
Motor Encoder Cable	2TC3025 2TC3075 2TC4025 2TC4075 2TC4100 2TC4300	D2-3305
DeviceNet Network Option Board	2DV3000	MAN0096-03
ControlNet Network Option Board	2CN3000	D2-3390
InterBus-S Network Option Board	2NB3000	49’1333
AutoMax Network Option Board with 762mm (30”) of Cable	2AX3000	D2-3308
Johnson Metasys N2 Option Board	2MT3000	HE-HGV3MT
Landis and Staefa P1 Option Board	2LS3000	Horner Electric Application 2710 Manual
Modbus Option Board	2MB3000	MAN0183-02
PROFIBUS Option Board	2PB3000	49’1355
AutoMax RS-232 Adapter Cable	2CA3001	D2-3348
Operator Interface Module (OIM)	2RK3000	D2-3342
CS3000 Control and Configuration Software	2CS3000	D2-3348
CS3000 RS-232 Computer Cable	2CA3000	D2-3348
115 VAC Interface Option Board	2LB3000	D2-3376

CHAPTER 3
Planning the Installation

This chapter provides how to plan a LiquiFlo drive installation.

ATTENTION: Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

ATTENTION: When the level-sense start feature is enabled (P.054 = ON), the user must ensure that automatic start up of the driven equipment will not cause injury to operating personnel or damage to the driven equipment. In addition, the user is responsible for providing suitable audible or visual alarms or other devices to indicate that this function is enabled and the drive may start at any moment. Refer to the LiquiFlo Software Start-Up and Reference manual for additional information. Failure to observe this precaution could result in severe bodily injury or loss of life.

ATTENTION: Use of power correction capacitors on the output of the drive can result in erratic operation of the motor, nuisance tripping, and/or permanent damage to the drive. Remove power correction capacitors before proceeding. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

ATTENTION: The user is responsible for conforming with all applicable local, national, and international codes. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

3.1 General Requirements for the Installation Site

It is important to properly plan before installing a LiquiFlo drive to ensure that the drive's environment and operating conditions are satisfactory. Read the following recommendations before continuing with drive installation.

3.1.1 Making Sure Environmental Conditions are Met

Before deciding on an installation site, consider the following guidelines:

- Verify that open-chassis style drives can be kept clean and dry. LiquiFlo drives must be placed in an enclosure.
- The area chosen should allow the space required for proper air flow as defined in section 3.1.3.
- Be sure that open-chassis style drives are installed away from oil, coolants, or other airborne contaminants.

- Do not install the drive above 1000 meters (3300 feet) without derating output power. For every 91.4 meters (300 feet) above 1000 meters (3300 feet), derate the output current 1%.
- Verify that the drive location will meet the environmental conditions specified in table 3.1.

Table 3.1 – Environmental Conditions

Condition	Specification
Operating Temperature (inside a NEMA cabinet)	0°C to +55°C[1] (32° to 131°F)
Storage Temperature (Ambient)	-40°C to 65°C (–40° to 149°F)
Humidity	5% to 95% (non-condensing)

[1]With typical heat rise inside a cabinet, 40°C ambient outside usually results in 55°C inside.

3.1.2 Determining Total Area Required Based on Drive Dimensions

Drive dimensions and weights are listed in table 3.2. Overall drive dimensions are illustrated in figures 3.1, 3.2, and 3.3 as an aid in calculating the total area required by the LiquiFlo drives.

Table 3.2 – Drive Dimensions and Weights

LiquiFlo Drive M/N	Frame	Dim. A	Dim. B	Dim. C	Dim. D	Dim. E	Dim. F	Dim. G	Weight
41L4060 41LR4060	B	475 mm 18.69”	800 mm 31.52”	357 mm 14.06”	397 mm 15.63”	711mm 28.00”	39 mm 1.53”	20 mm 0.79”	125 kg 275 lb
50LW4060 50LR4060	C	583 mm 22.96”	971 mm 38.23”	347 mm 13.66”	464 mm 18.25”	787 mm 31.00”	28 mm 1.09”	25 mm 1.00”	168 kg 370 lb
64LW4060 64LR4060	C	583 mm 22.96”	971 mm 38.23”	347 mm 13.66”	464 mm 18.25”	787 mm 31.00”	28 mm 1.09”	25 mm 1.00”	170 kg 375 lb
120L4060	D	1010 mm 39.75”	1245 mm 49.00”	360 mm 14.16”	838 mm 33.00”	1200 mm 47.25”	29 mm 1.12”	25 mm 1.00”	386 kg 850 lb

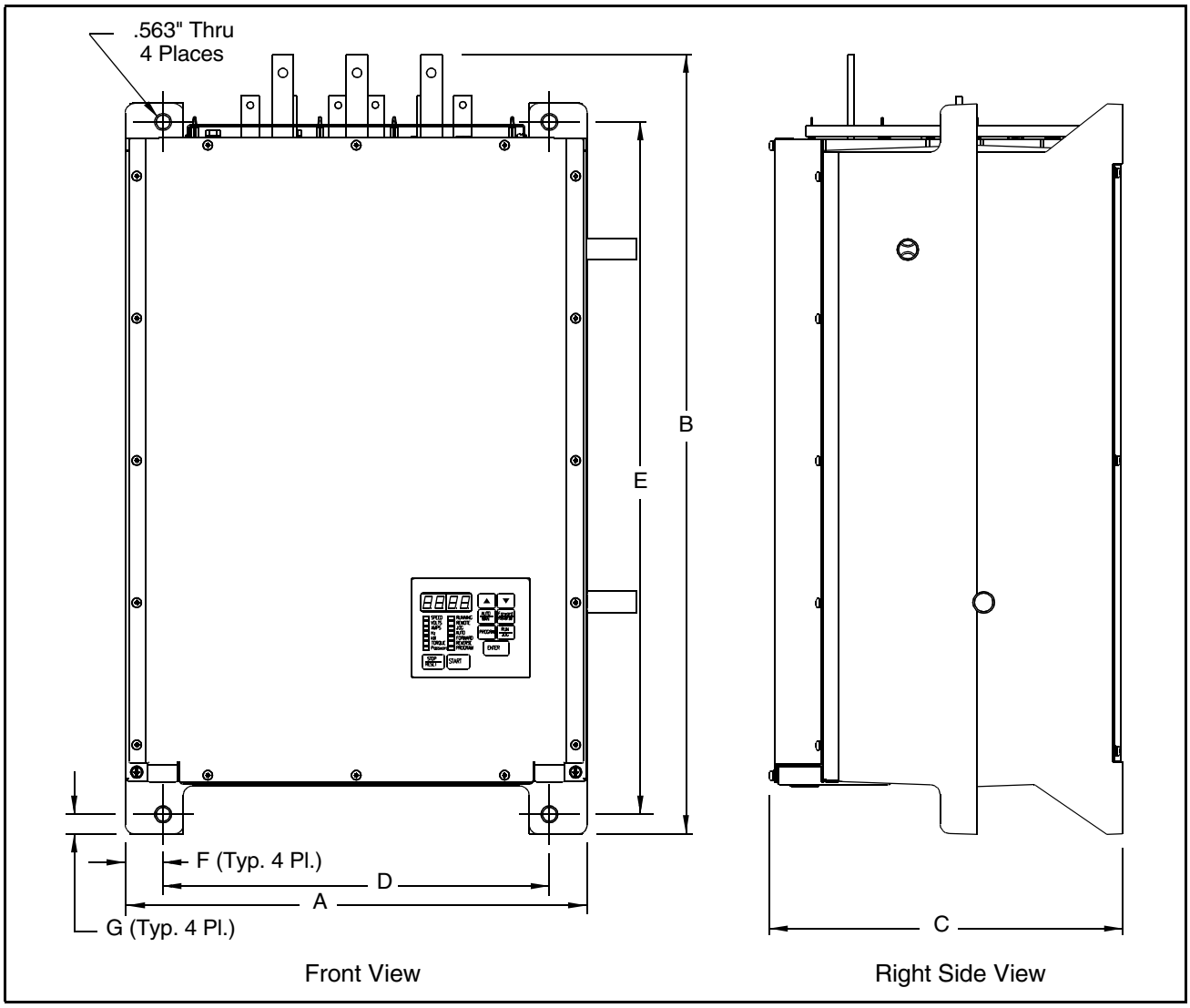
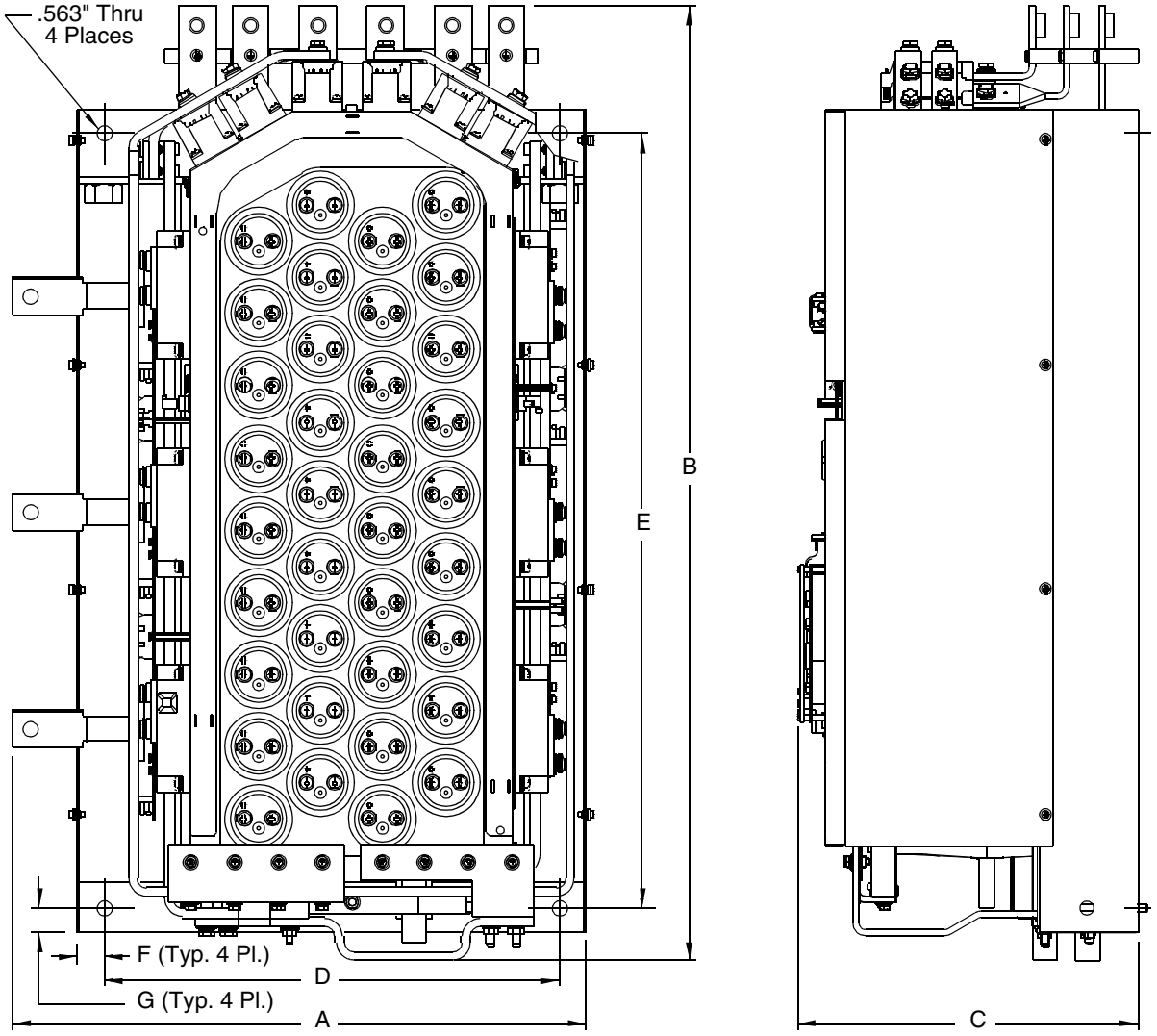


Figure 3.1 – B-Frame Drive Dimensions



Front View (Control Panel Assembly and Bus Laminate Removed)

Right Side View

Figure 3.2 – C-Frame Drive Dimensions

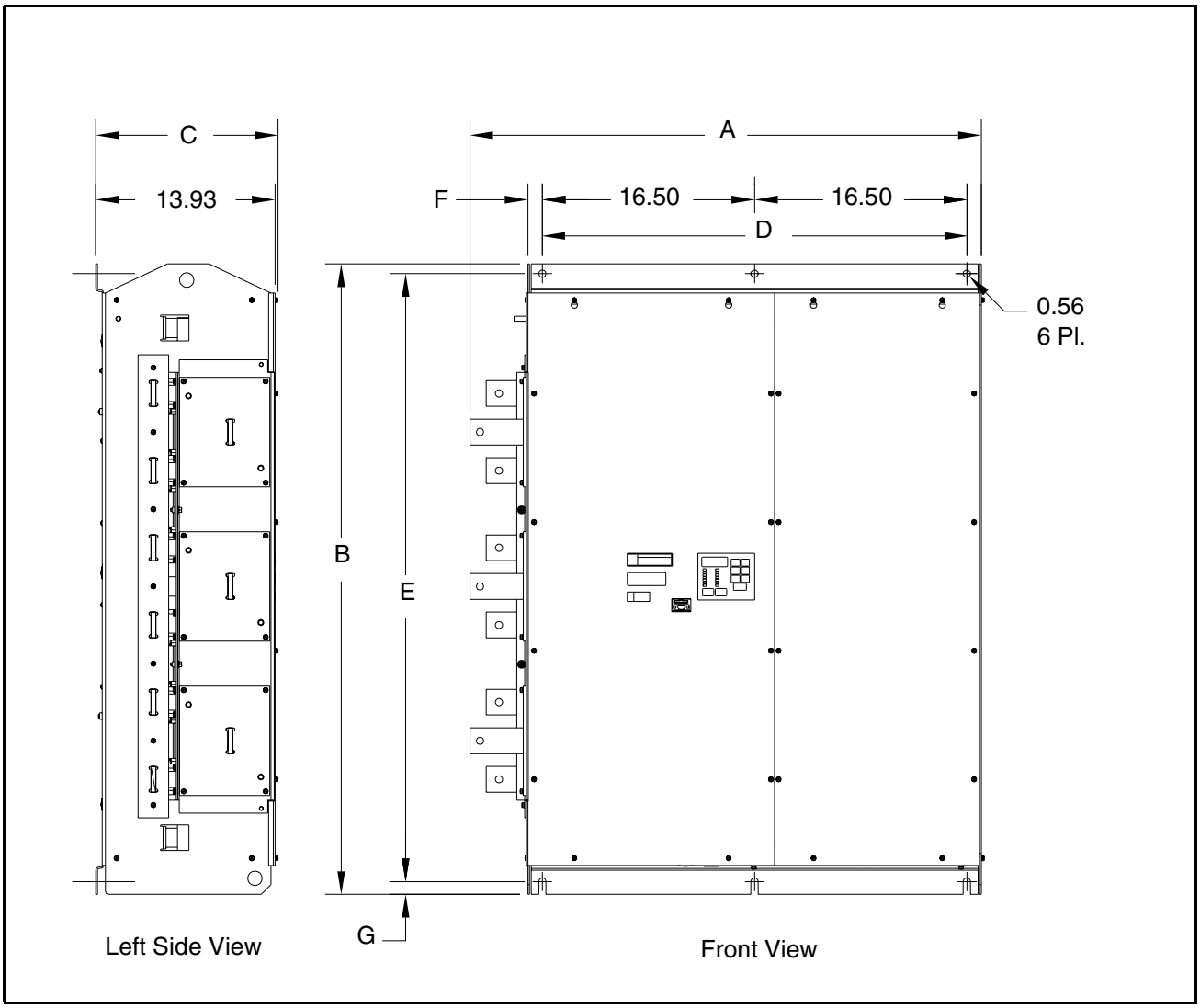


Figure 3.3 – D-Frame Drive Dimensions

3.1.3 Verifying the Site Provides for Recommended Air Flow Clearances

Be sure there is adequate clearance for air circulation around the user-supplied enclosure. A 6-inch minimum clearance is required wherever vents are located in the cabinet.

3.1.4 Verifying Power Module Input Ratings Match Supplied Power

It is important to verify that plant power will meet the input power requirements of the LiquiFlo drive's Power Module circuitry. Refer to table 2.1 for input power rating specifications. Be sure input power to the drive corresponds to the drive nameplate voltage and frequency.

3.2 Wiring Requirements for the Drive

Certain drive requirements should be checked before continuing with the drive installation. Wire sizes, branch circuit protection, encoder feedback (for FVC regulation), and E-stop wiring (see chapter 7) are all areas that need to be evaluated.

3.2.1 Meeting Terminal Strip Input and Output Specifications

The terminal strip on the Regulator board provides terminals for 24 VDC power for the eight remote control inputs. Refer to tables A.3 and A.4 for control input and output specifications.

3.2.2 Determining Wire Size Requirements

Wire size should be determined based on the size of conduit openings, and applicable local, national, and international codes (e.g., NEC/CEC regulations).

ATTENTION: The user is responsible for conforming with all applicable local, national, and international codes. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

3.2.2.1 Conduit Entry Opening Sizes

It is important to determine the size of the conduit openings in the cabinet that the drive is mounted in so that the wire planned for a specific entry point will fit through the opening.

3.2.2.2 Recommended Power Wire Sizes

Input power wiring should be copper and should be sized according to applicable codes to handle the drive's continuous-rated input current. Output wiring should be copper and should be sized according to applicable codes to handle the drive's continuous-rated output current. See tables 3.3, 3.4, and 3.5 for recommended power wire sizes. See figures 5.1 and 5.2 for input and output wiring connections.

Table 3.3 – Recommended Power Wire Sizes for B-Frame Drives

Type of Power Wiring	Drive M/N 41L4060, 41LR4060 with kit M/N 41L4060PM
AC Input Power (R/L1, S/L2, T/L3)	Lug[1] accepts two (2) 300 MCM to 6 AWG conductors
Output Power (U/T1, V/T2, W/T3)	
Delta-Wye Transformer (S1 to S6)	
Ground (PE)	

[1]Lugs not provided with standard drive. They are available as part of kit M/N 41L4060PM.

Table 3.4 – Recommended Power Wire Sizes for C-Frame Drives

Type of Power Wiring	Drive M/N 50LW4060, 50LR4060, 64LW4060, 64LR4060 with kit M/N 64L4060PM
AC Input Power (R/L1, S/L2, T/L3)	Lug[1] accepts two (2) 350 MCM to 4 AWG conductors
Output Power (U/T1, V/T2, W/T3)	
Delta-Wye Transformer (S1 to S6)	
Ground (PE)	

[1]Lugs not provided with standard drive. They are available as part of kit M/N 64L4060PM.

Table 3.5 – Recommended Power Wire Sizes for D-Frame Drives

Type of Power Wiring	Drive M/N 120L4060 with kit M/N 120L4060PM
AC Input Power (R/L1, S/L2, T/L3)	Lug[1] accepts two (2) 800 MCM to 300 MCM conductors
Output Power (U/T1, V/T2, W/T3)	
Delta-Wye Transformer (S1 to S6)	
Ground (PE)	

[1]Lugs not provided with standard drive. They are available as part of kit M/N 120L4060PM.

3.2.2.3 Recommended Control and Signal Wire Sizes

The recommended wire sizes to connect I/O signals to the terminal strip on the Regulator board and RMI board are shown in table 3.6. Recommended terminal tightening torque is 0.5 Newton-meters (4.5 in-lbs). Operator controls can be up to 303 meters (1000 feet) from the LiquiFlo drive.

Table 3.6 – Recommended Terminal Strip Wire Sizes

Terminals	Wire Size
1 to 31 (Regulator) 41 to 69 (RMI)	20 to 14 AWG, 2 to 0.5 (mm^2)

3.2.2.4 Recommended Motor Lead Lengths

Motor lead lengths can total up to 76 meters (250 feet).

3.2.2.5 Recommended Serial Communication Cable Lengths

Connector J8 on the Regulator boards is an RS-232 serial communication port. This connector allows the LiquiFlo drive to communicate with external devices such as a personal computer using RS-232 protocol. See table A.5.

Two RS-232 cables are available from Reliance Electric:

- A 3 meter (10 feet) D-shell 9-pin to 9-pin cable (M/N 2CA3000)
- A 0.3 meter (1 foot) D-shell 9-pin to 25-pin adaptor cable (M/N 2CA3001).

User-constructed cables can be up to 15 meters (50 feet) in length.

Note that for communication between a LiquiFlo drive and a personal computer, the Control and Configuration Software must also be used. Refer to instruction manual D2-3348 for more information about the CS3000 software.

The Regulator boards have one set of RS-232 transmit/receive lines. These lines can be accessed by only one device at a time: connector J8, the RS-232 terminals (1-3) on the terminal strip, or an Operator Interface Module (OIM).

3.2.3 Selecting Input Line Branch Circuit Fuses

ATTENTION: Most codes require that upstream branch circuit protection be provided to protect input power wiring. Install the fuses recommended in table 3.6. Do not exceed the fuse ratings. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Input line branch circuit protection fuses must be used to protect the input power lines. See figures 5.1 and 5.2. Recommended fuse values are shown in table 3.7. The input fuse ratings listed in table 3.7 are applicable for one drive per branch circuit. No other load may be applied to that fused circuit.

Table 3.7 – AC Input Line Fuse and Circuit Breaker Selection Values

Model Number	Input Voltage (+/-10%)	Fuse Rating	Motor Circuit Protector or Circuit Breaker
41L4060 41LR4060	380-480 VAC	600 A[1]	600 A
50LW4060 50LR4060	380-480 VAC	750 A[2]	800 A
64LW4060 64LR4060	380-480 VAC	1000 A[2]	1000 A
120L4060	380-480 VAC	1600 A[2]	1500 A

[1]Recommended fuse type: UL Class J, 600 V, time-delay, or equivalent.

[2]Recommended fuse type: UL Class L, 600 V, time-delay, or equivalent.

3.2.4 Meeting Encoder Specifications (FVC Regulation Only)

LiquiFlo drives set up for FVC regulation require an encoder for closed-loop operation. Refer to table A.6 for specifications. Drives set up for V/Hz or SVC regulation do not require an encoder for feedback because they operate in the open loop mode.

3.2.4.1 Encoder Wiring Guidelines

Encoder connections are considered signal level wiring and, therefore, must be run separate from control and power wiring. Reliance Electric recommends 18 AWG unshielded twisted pair wires with 2-3 twists per inch for applications to a maximum distance of 303 meters (1000 feet). The recommended Reliance Electric part number is 417900-207CG, 18 AWG, 6 conductor (3 twisted pairs).

3.2.5 Verifying Power Module Output Current Rating Is Greater Than Motor Full Load Amps

Verify that the LiquiFlo output current rating is equal to or greater than the motor's full load current (amps). Table 2.1 lists the output current values.

CHAPTER 4

Mounting the Drive, Grounding, and Finding Wire Routing Locations

This chapter shows how to mount the drive and properly ground it. Also shown are the entry areas where wiring is to be routed in and out of the drive.

4.1 Lifting and Mounting the Drive

Use the following procedure to lift the LiquiFlo drive and mount it in the required enclosure:

Step 1. **For M/N 50LW4060, 50LR4060, 64LW4060, and 64LR4060,** install two eyebolts into the drive to serve as lifting points. Two 3/4” nuts are welded to the drive’s baseplate. Screw two eyebolts (2” eye I.D., 6” long shank) into the nuts.

For M/N 41L4060 or 41LR4060, install two clevis clamps into the drive to serve as lifting points. Two 9/16” through holes are machined into the casting protrusions.

For M/N 120L4060, install two clevis pins into the drive to serve as lifting points. Two 1.00" through holes are provided in the sheet metal chassis.

Step 2. **For M/N 41L4060, 41LR4060, M/N 50LW4060, 50LR4060, 64LW4060, and 64LR4060,** connect 18” (nominal) of chain between the eyebolts or attached clevis clamps and secure them with a clevis clamp.

For M/N 120L4060, connect 50" (nominal) of chain between the eyebolts or attached clevis clamps and secure them with a clevis clamp.

Step 3. Using an overhead or portable hoist (minimum 1/2 ton rated capacity), attach a free-fall chain to the chain secured to the drive. Take up any vertical slack in the chain.

Step 4. Using the hoist, lift the drive from the horizontal shipping pallet.

Step 5. Position the drive in the enclosure.

Step 6. **For M/N 41L4060, 41LR4060, M/N 50LW4060, 50LR4060, 64LW4060, and 64LR4060,** attach the drive to the vertical surface selected using the four (4) mounting holes provided.

For M/N 120L4060, attach the drive to the vertical surface using the six (6) mounting holes provided.

In order to maintain a flat mounting surface and to ensure that bolt tightness is maintained, use flat washers and split-ring lock washers under the bolt heads. Refer to table 3.2 and figures 3.1 to 3.3 for drive mounting dimensions. Use the following user-supplied mounting bolts and washers on C-frame drives: 1/2”-13, UN/UNC-2A, Grade 2.

Step 7. **For M/N 50LW4060, 50LR4060, 64LW4060, and 64LR4060,** remove the eyebolts and the chain between them.

For M/N 41L4060, 41LR4060, and 120L4060, remove the clevis clamps and chain between them.

4.1.1 Verifying the Drive’s Watts Loss Rating

When mounting the drive inside of an enclosure, you should determine the watts loss rating of the drive from table 2.1. This table lists the typical full load power loss watts value at 2 kHz (rated carrier frequency). Ensure that the enclosure is adequately ventilated with 0° to 40°C ambient air based on the drive’s watts loss rating.

4.2 Determining Input, Motor Output, Ground, and Control Wire Routing for the Drive

All wiring should be installed in conformance with the applicable local, national, and international codes (e.g., NEC/CEC). Signal wiring, control wiring, and power wiring must be routed in separate conduits to prevent interference with drive operation. Use grommets, when hubs are not provided, to guard against wire chafing. Figures 4.1, 4.2, and 4.3 show the wire routing, grounding terminal, and power terminal strips of the B-frame, C-frame, and D-frame LiquiFlo drives.

ATTENTION: Do not route signal and control wiring with power wiring in the same conduit. This can cause interference with drive operation. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Do not route more than three sets of motor leads through a single conduit. This will minimize cross-talk that could reduce the effectiveness of noise reduction methods. If more than three drive/motor connections per conduit are required, shielded cable must be used. If possible, each conduit should contain only one set of motor leads.

ATTENTION: Unused wires in conduit must be grounded at both ends to avoid a possible shock hazard caused by induced voltages. Also, if a drive sharing a conduit is being serviced or installed, all drives using this conduit should be disabled to eliminate the possible shock hazard from cross-coupled motor leads. Failure to observe these precautions could result in bodily injury.

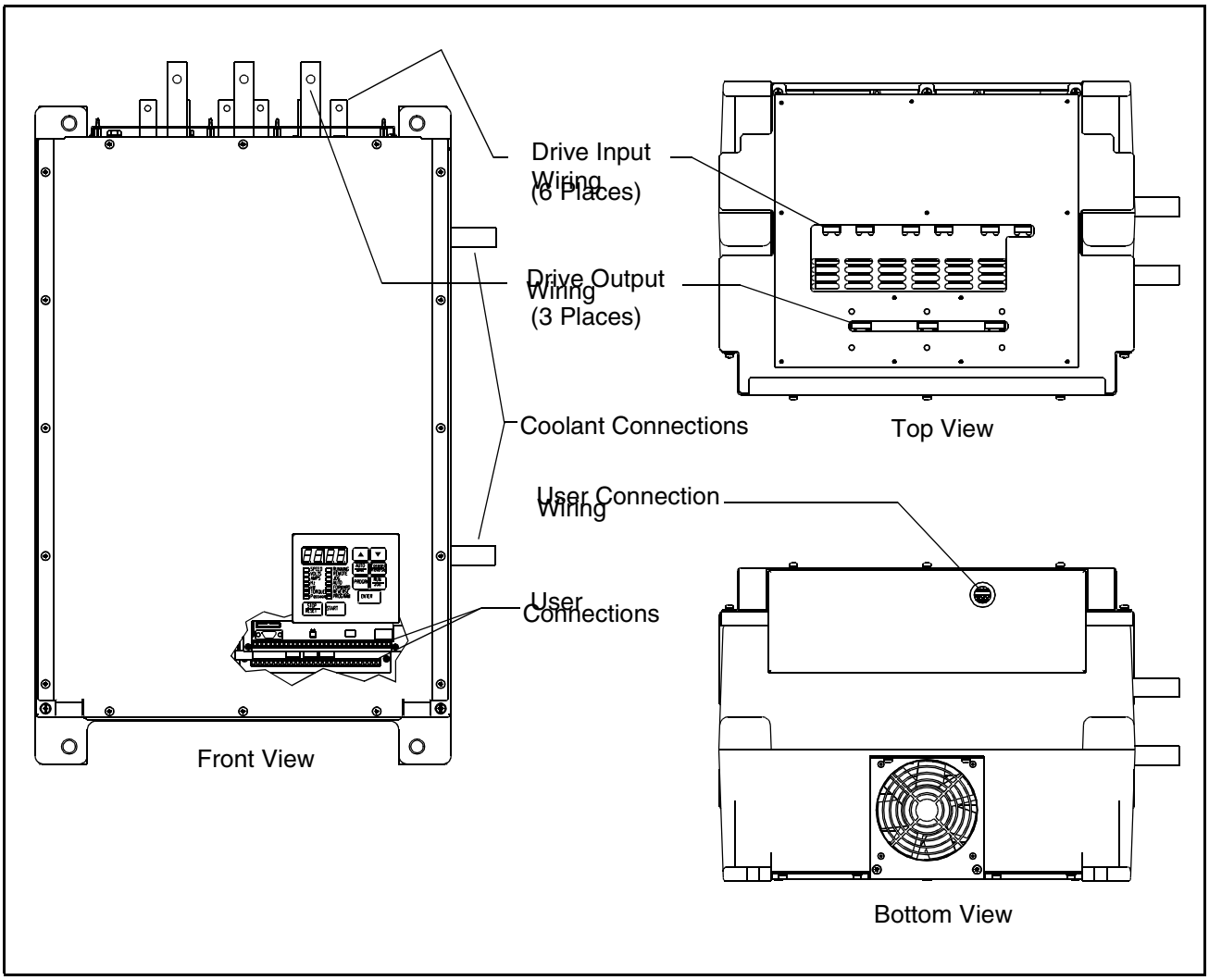


Figure 4.1 – Wire Routing Locations for B-Frame LiquiFlo Drives

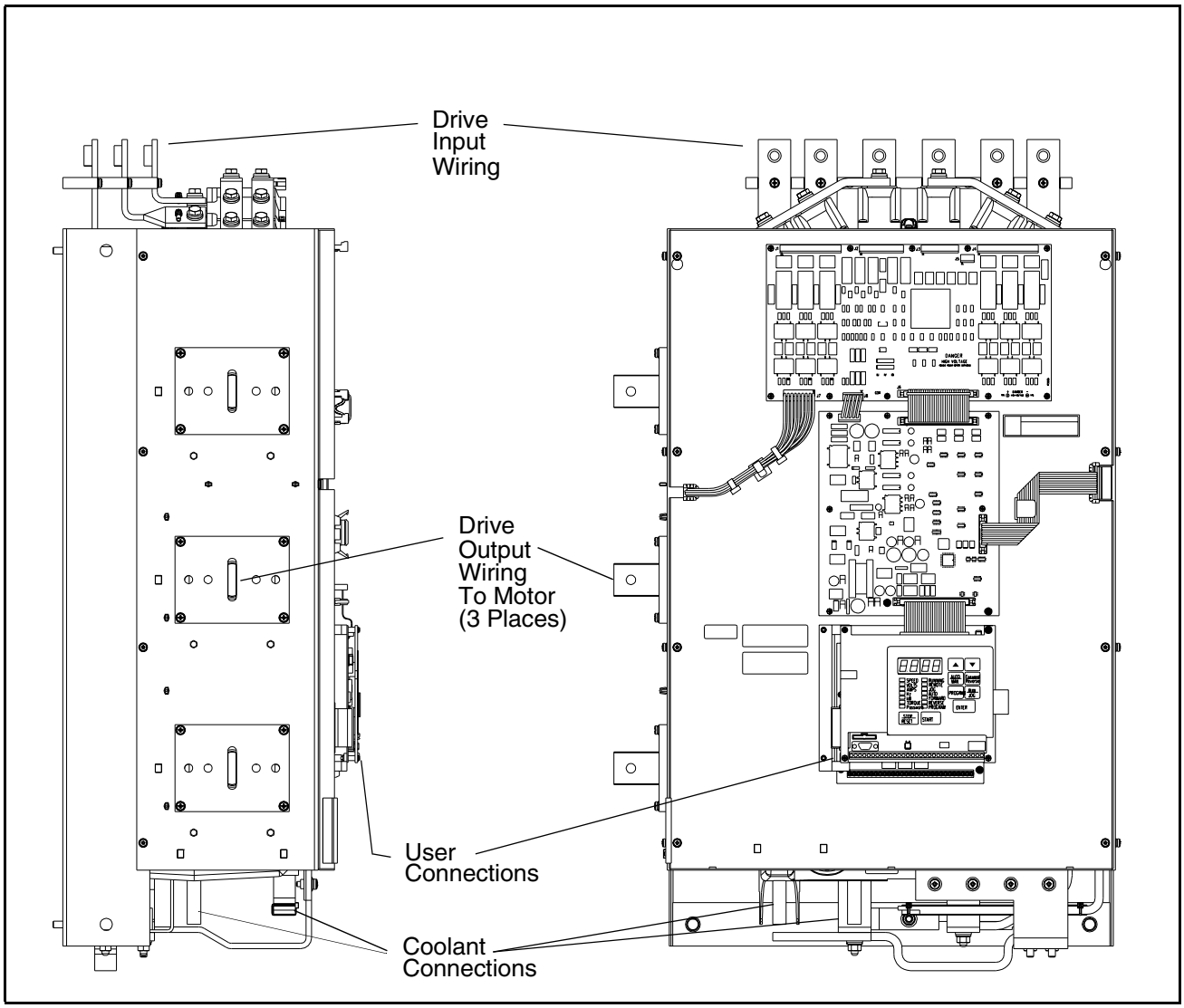


Figure 4.2 – Wire Routing Locations for C-Frame LiquiFlo Drives

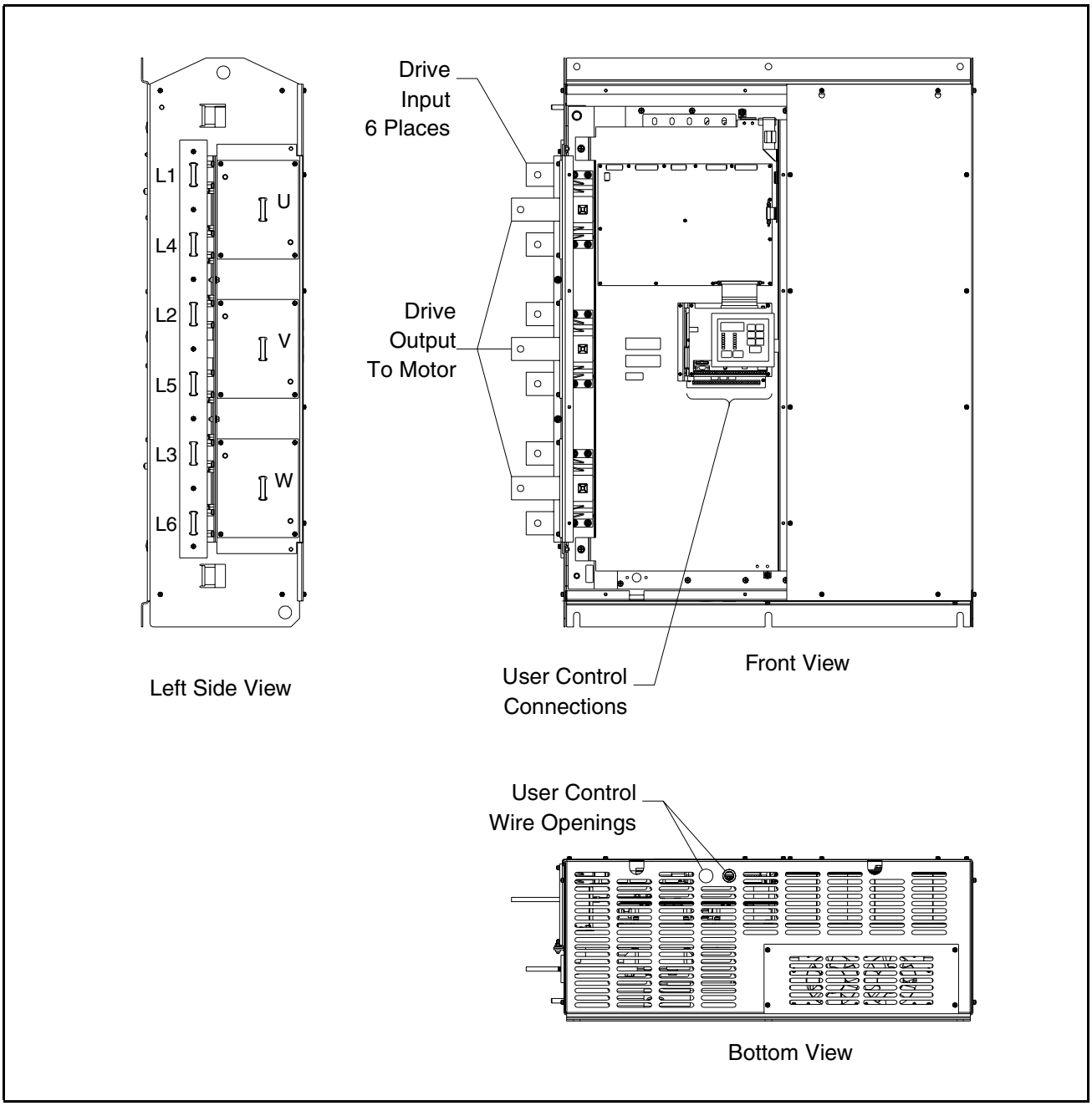


Figure 4.3 – Wire Routing Locations for D-Frame LiquiFlo Drives

4.3 Installing the DC Bus Reactor Fan (C-Frame Drives Only)

A fan must be installed in the LiquiFlo drive enclosure to keep the DC bus reactor at the proper operating temperature. The fan should be a Comair Rotron M/N PT2B3 rated at 0.26 amps, 31 watts, 235 CFM (115 VAC, 60 Hz), or equivalent.

Use the following procedure to install the DC bus reactor fan:

Step 1. Open the door of the enclosure.

Step 2. Mount the fan beneath the drive in the enclosure as shown in figure 4.4 such that the air flow is directed up through the drive.

Step 3. Connect the fan to a 115 VAC, 60 Hz power source inside of the enclosure.

Step 4. Close the door of the enclosure.

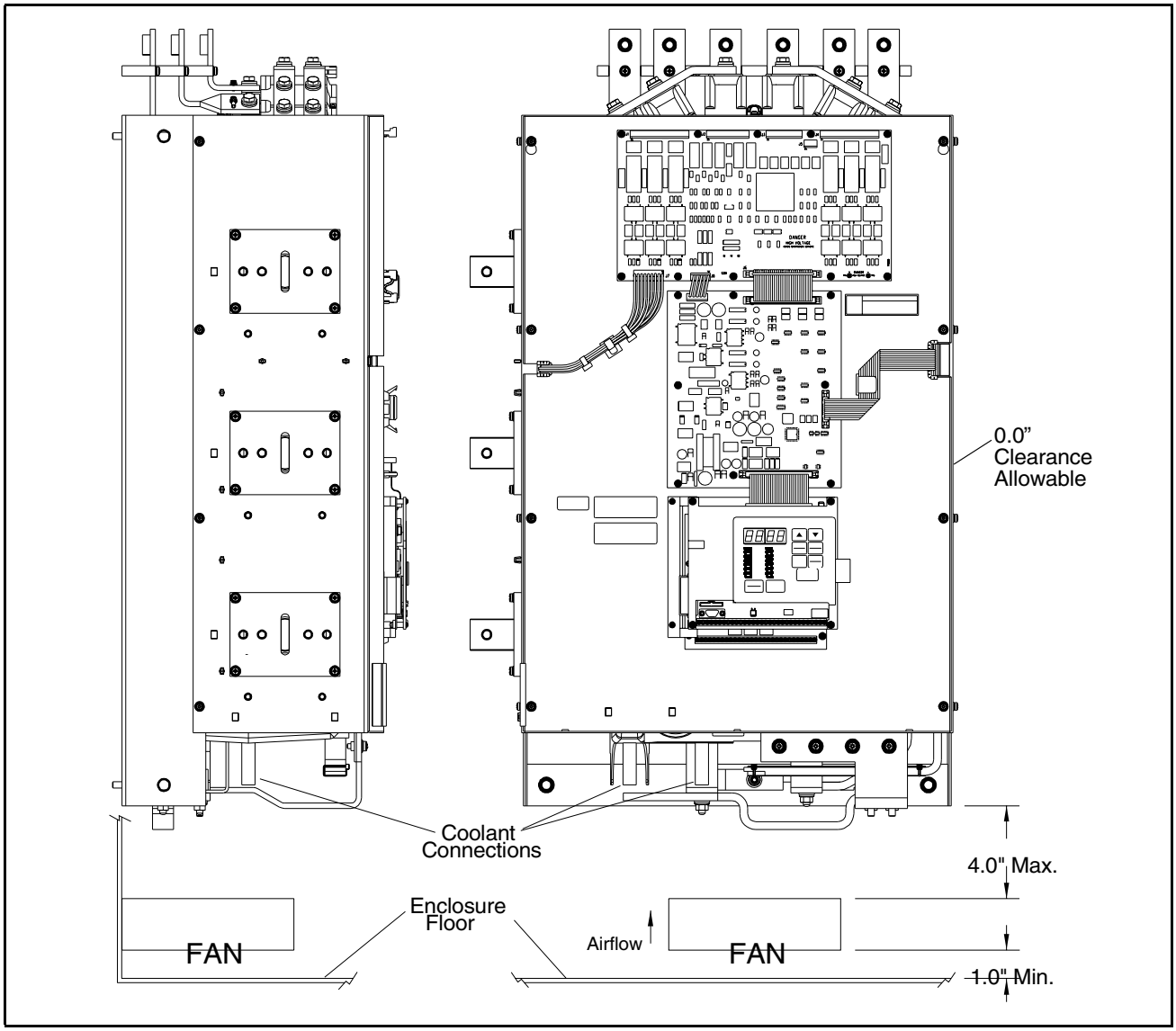


Figure 4.4 – DC Bus Reactor Cooling Fan Mounting Location

4.4 Grounding the Drive

ATTENTION: The user is responsible for conforming with all applicable local, national, and international codes. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Use the following steps to ground the drive:

Step 1. Open the door of the enclosure.

Step 2. Run a suitable equipment grounding conductor unbroken from the drive to the motor's ground terminal and then to earth ground. (For B and C-frame drives, use one of the bolts that pass through the drive baseplate and are used to fasten the drive to the wall or cabinet. For D-frame drives, use the ground stud provided.) See figures 4.1, 4.2, 4.3, 5.1, and 5.2. Tighten these grounding connections to the proper torque as shown in table 5.1.

Step 3. Connect a suitable grounding conductor to the motor frame and the remote control station (if used). Run each conductor unbroken to earth ground. When adding more than one grounding conductor wire to a single chassis ground, twist the conductors together. Tighten these grounding connections to the proper torque as shown in table 5.1.

Step 4. Close the door of the enclosure.

4.5 Connecting Coolant Lines

LiquiFlo drives are rated for use with clean, potable water as the coolant. Coolant must be properly filtered to ensure it is free from contamination. Some coolant fluids may allow an increased output rating while others may require a derating. For LiquiFlo drive M/N 41LR4060, contact Reliance Electric for additional information.

4.5.1 B-Frame Coolant Connections

B-frame LiquiFlo drives have inlet and outlet coolant connections as shown in figure 4.5. The inlet and outlet connectors are 3/4" nominal, 7/8" O.D. copper sweat fittings. Use the appropriate sweat fittings attached to hoses or copper tube for the coolant supply and return lines. Supply and return lines should be sized for 9 gpm/120 psi service with a maximum operating temperature of 40°C (104°F). Actual operating flow rate through the drive is 8 gpm at 10 psi. It is recommended that a flow switch be installed after the coolant outlet to shut off the drive if coolant flow drops below 4 gpm. It is also recommended that the water pump not be powered unless the drive is also powered. Failure to do this may result in condensation accumulating on the casting and/or circuit boards, which could damage the drive.

4.5.2 C-Frame Coolant Connections

C-frame LiquiFlo drives have inlet and outlet coolant connections as shown in figure 4.6. The inlet and outlet connectors are size 10, SAE 37° flare female fittings. Use the appropriate male fittings attached to hoses or for the coolant supply and return lines. These fittings should be torqued to 80 Nm (60 ft-lb). Supply and return lines should be sized for 5 gpm/120 psi service with a maximum operating temperature of 40°C (104°F). Actual operating flow rate through the drive is 5 gpm at 30 psi. It is recommended that a flow switch be installed after the coolant outlet to shut off the drive if coolant flow drops below 4 gpm. It is also recommended that the water pump

not be powered unless the drive is also powered. Failure to do this may result in condensation accumulating on the casting and/or circuit boards, which could damage the drive.

4.5.3 D-Frame Coolant Connections

D-frame LiquiFlo drives have inlet and outlet coolant connections as shown in figure 4.7. The inlet and outlet connections are tapped holes suitable for two bolt-hole flanges. The internal threads of the tapped holes are 5/16-18 UNC-2B. The depth of thread is 3/4". The center-to-center hole dimension is 1.625". Use the appropriate sweat fittings to connect the two bolt-hole flanges to hoses or copper tube. For adequate sealing, a compressed fiber gasket is required between each flange and the drive. For bolted joint strength, use a 5/16" split ring lockwasher between each 5/16-18 bolt and flange and a nonpermanent thread locking compound on each bolt. The flange screws should be torqued to 13.6 Nm (10 ft-lb). Supply and return lines should be sized for 9 gpm/50 psi service with a maximum operating temperature of 40°C (104°F). A pressure regulator or pressure relief device to control the drive inlet pressure below 50 psi is recommended. Actual operating flow rate through the drive is 8 gpm at 10 psi. It is recommended that a flow switch be installed after the coolant outlet to shut off the drive if the coolant flow drops below 4 gpm. It is also recommended that the water pump not be powered unless the drive is also powered.

A corrosion inhibitor is required. An approved source is Chemtool Inc., part number CT787-C. The recommended concentration of the inhibitor is 2% by volume.

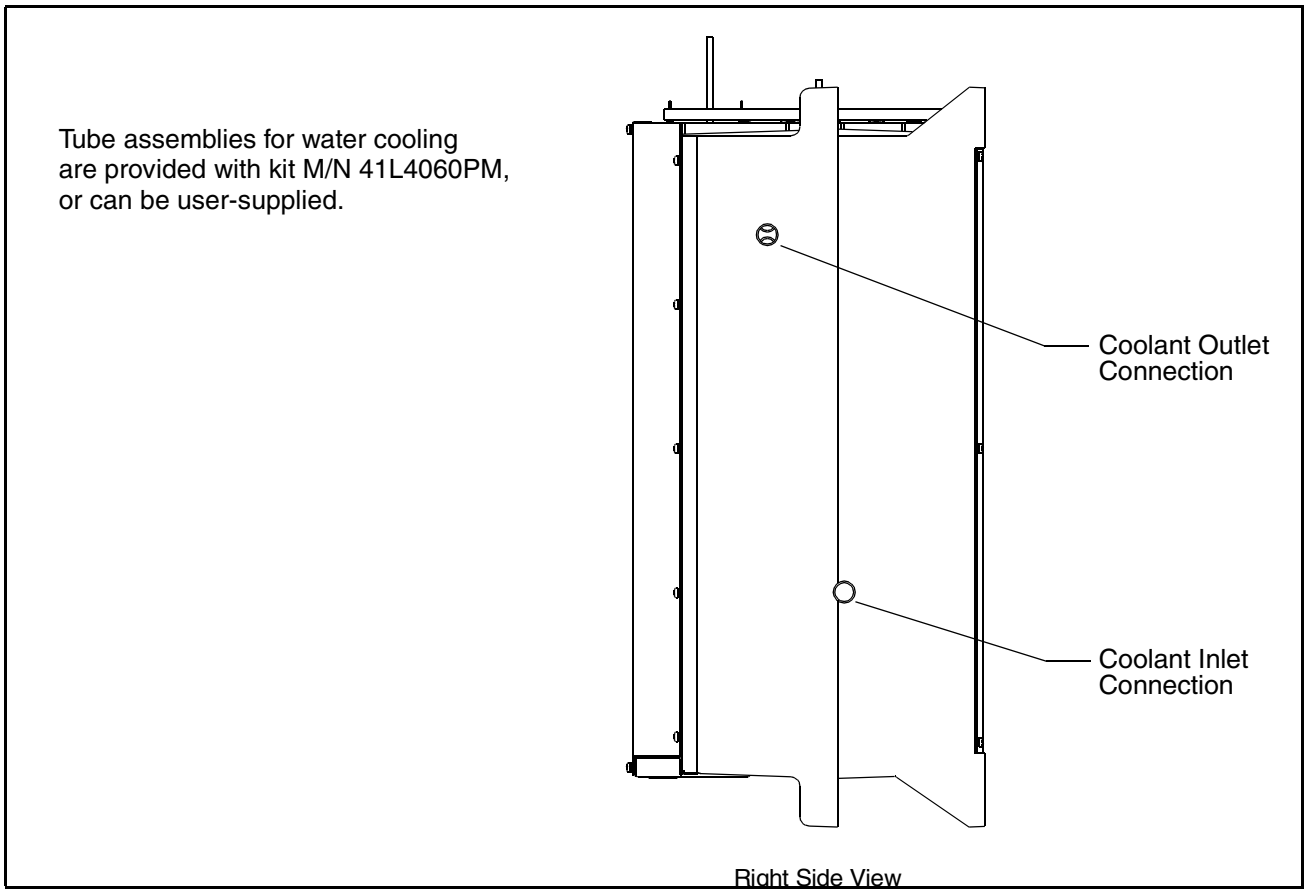

Tube assemblies for water cooling are provided with kit M/N 41L4060PM, or can be user-supplied.
Coolant Outlet Connection
Coolant Inlet Connection
Right Side View

Figure 4.5 – Coolant Connector Locations for B-Frame LiquiFlo Drives

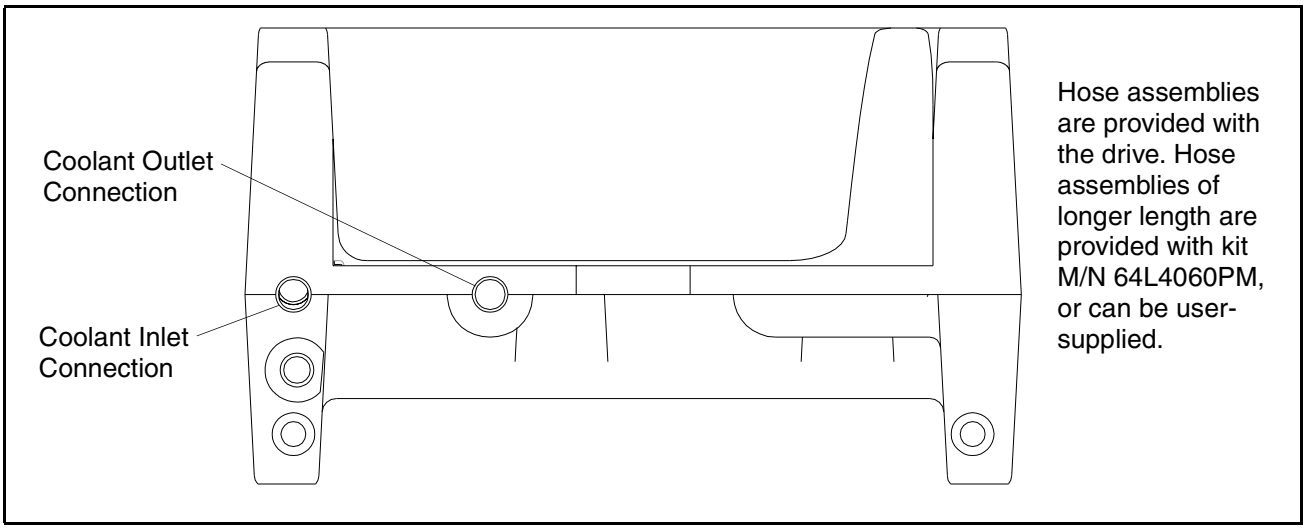

Coolant Outlet Connection
Coolant Inlet Connection
Hose assemblies are provided with the drive. Hose assemblies of longer length are provided with kit M/N 64L4060PM, or can be user-supplied.

Figure 4.6 – Coolant Connector Locations for C-Frame LiquiFlo Drives

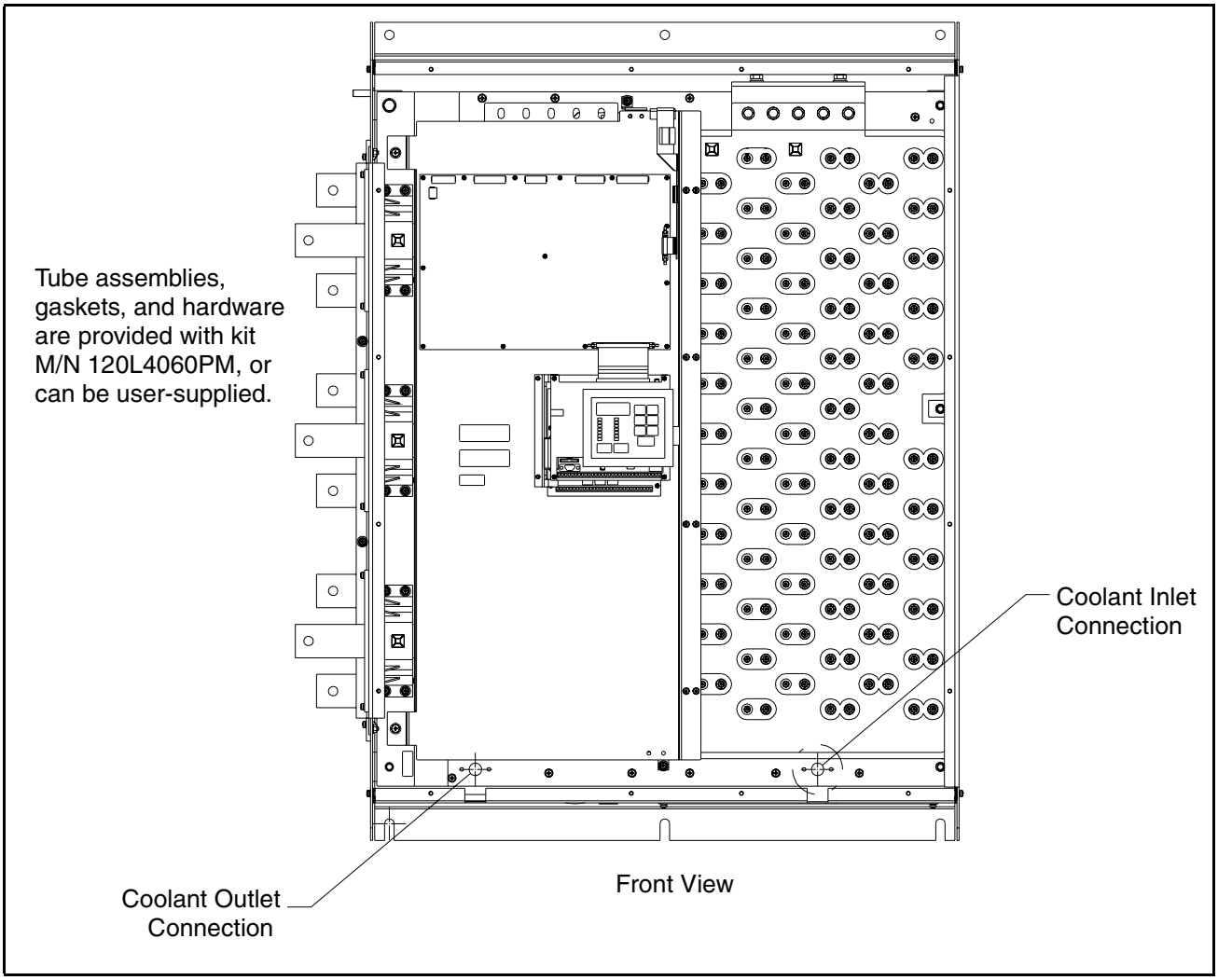

Tube assemblies, gaskets, and hardware are provided with kit M/N 120L4060PM, or can be user-supplied.
Coolant Inlet Connection
Coolant Outlet Connection
Front View

Figure 4.7 – Coolant Connector Locations for D-Frame LiquiFlo Drives

CHAPTER 5

Installing Input Power Wiring

This chapter describes incoming line components and how to install them.

5.1 Installing Transformers and Reactors (Optional)

The LiquiFlo AC drive may be used on distribution systems with 85,000 amps or less symmetrical fault current capacity. Line reactors are not needed for safe operation of the drive but may be required to reduce line harmonics.

Input isolation transformers might be needed to help eliminate the following:

- Damaging line voltage transients from reaching the drive.
- Line noise from the drive back to the incoming power source.
- Damaging currents that could develop if a point inside the drive becomes grounded.

Observe the following guidelines when installing an isolation transformer:

- A power disconnecting device must be installed between the power line and the primary of the transformer.
- If the power disconnecting device is a circuit breaker, the circuit breaker trip rating must be coordinated with the in-rush current (10 to 12 times full load current) of the transformer.

5.2 Installing Fuses for Branch Circuit Protection

Install the required, user-supplied branch circuit protection fuses according to the applicable local, national, and international codes (e.g., NEC/CEC). The fuses must be installed in the line before the drive input terminals. See figures 5.1 and 5.2. Fuse value selections are provided in table 3.7.

ATTENTION: Most codes require that upstream branch protection be provided to protect input power wiring. Failure to observe this precaution could result in severe bodily injury or loss of life.

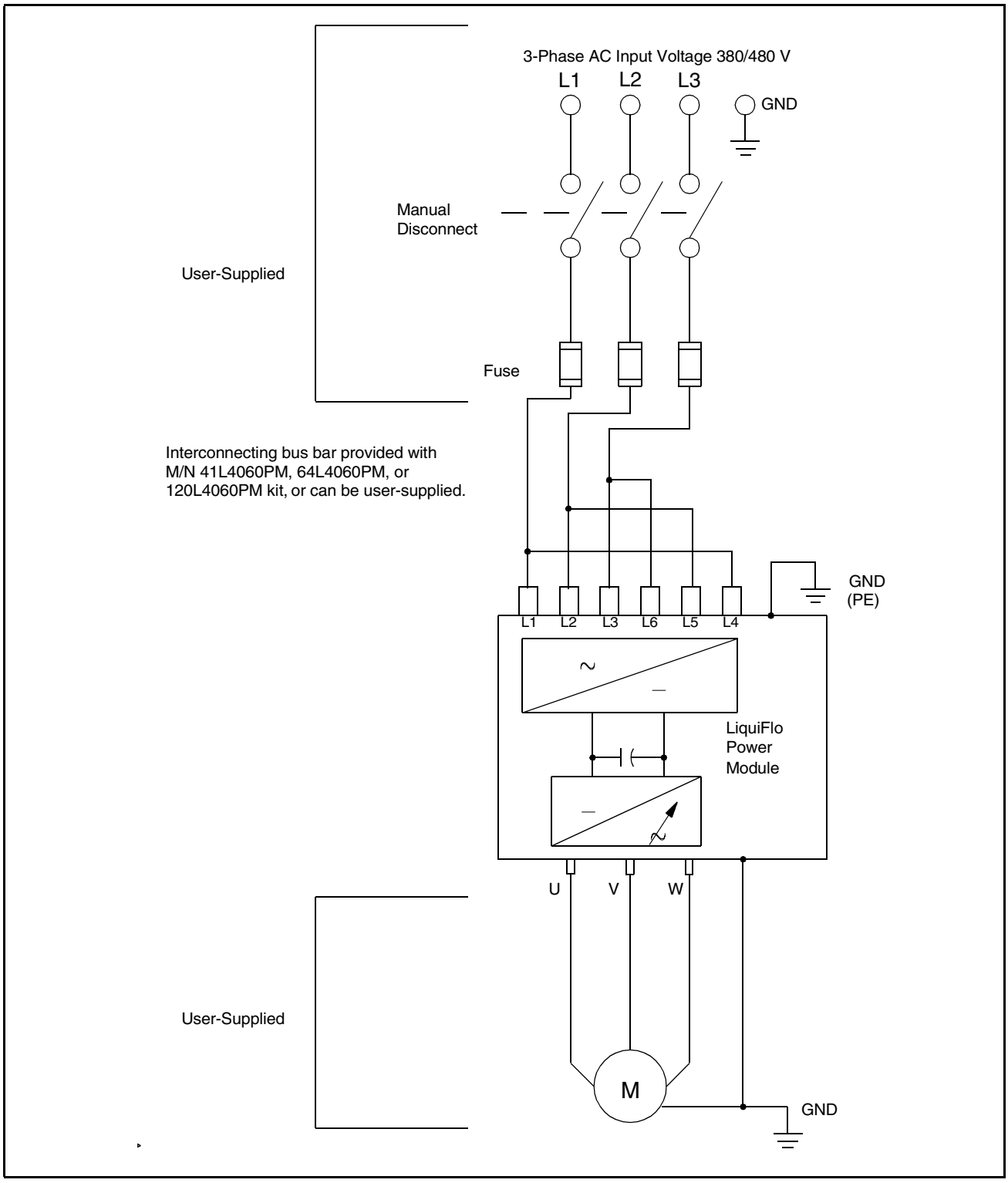


Figure 5.1 – Typical AC Input/Output Electrical Connections (6-Pulse Rectifier, All Frames)

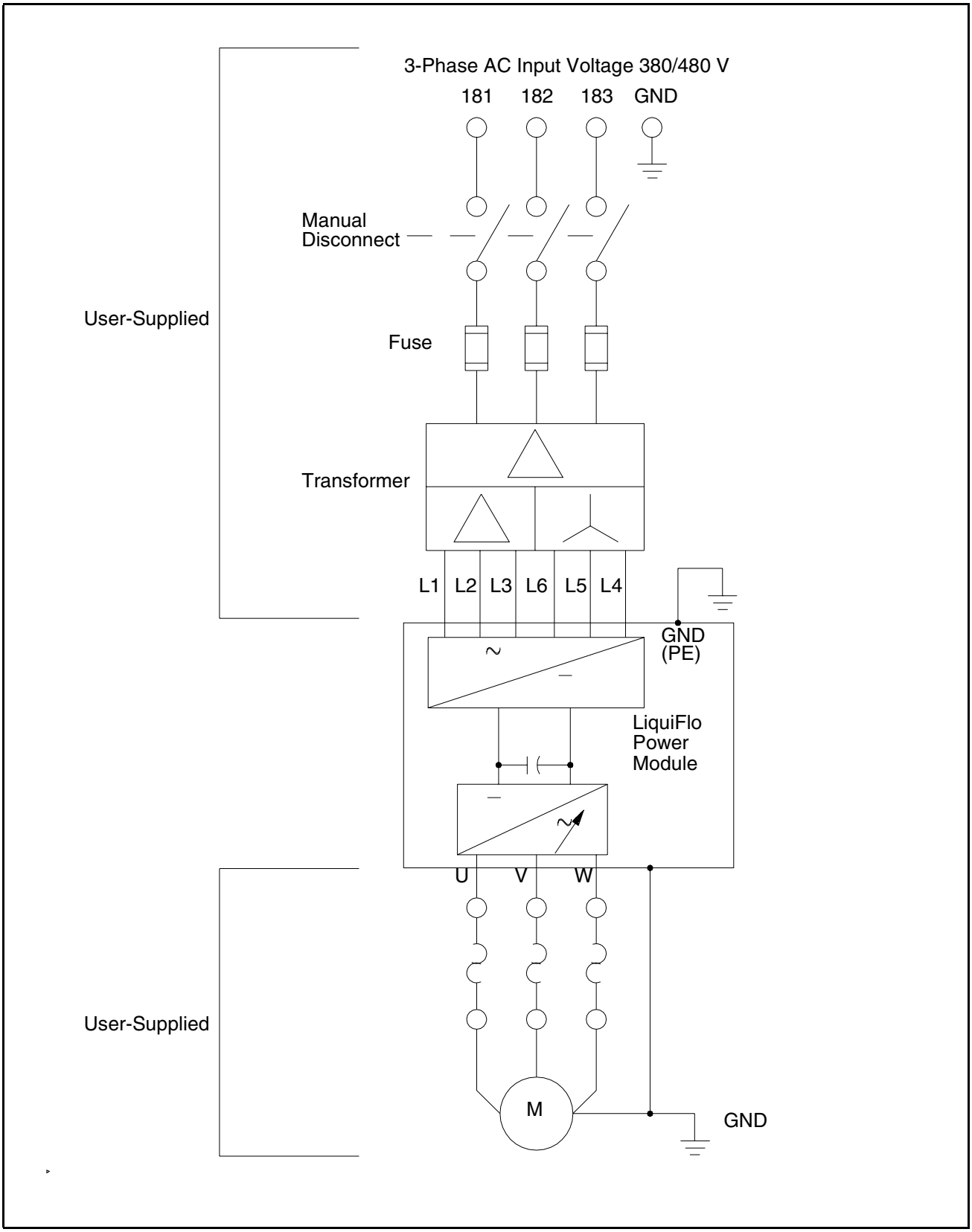


Figure 5.2 – Typical AC Input/Output Electrical Connections (12-Pulse Rectifier, B- and C-Frames Only)

5.3 Installing a Required External/Separate Input Disconnect

An input disconnect must be installed in the line before the drive input terminals in accordance with local, national, and international codes (e.g., NEC/CEC). The disconnect should be sized according to the in-rush current as well as any additional loads the disconnect might supply. The trip rating for the inrush current (10-12 times full load current) should be coordinated with that of the input isolation transformer, if used. Refer to section 5.1 for additional information.

5.4 Installing Power Wiring from the AC Input Line to the Drive's Power Terminals

Use the following steps to connect AC input power to the drive:

Step 1. Wire the AC input power leads by routing them as shown in figure 4.1. Tables 3.3. 3.4, and 3.5 contains the recommended power wiring sizes.

ATTENTION: Do not route signal and control wiring with power wiring in the same conduit. This can cause interference with drive operation. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Step 2. Connect the three-phase AC input power leads (three-wire 380-480 VAC) to the appropriate terminals.

On 6-pulse rectifier drives, connect the AC input power leads to the L1, L2, and L3 terminals. See figure 5.1.

On 12-pulse rectifier drives, connect the AC input power leads to the L1, L2, L3, L4, L5, and L6 terminals. See figure 5.2.

Step 3. Tighten the AC input power terminals to the proper torque as shown in table 5.1.

Table 5.1 – Terminal Tightening Torques

Drive Type	Terminals	Hardware Type	Maximum Tightening Torque (±10%)
B-Frame	L1 to L6	1/4-20, Gr. 5	13 Newton-meters (10 ft-lb)
	U, V, W	5/16-18, Gr. 5	24 Newton-meters (18 ft-lb)
	GND, PE	5/16 Hex	31 Newton-meters (23 ft-lb)
C-Frame	L1 to L6	1/2-13; Gr. 5	100 Newton-meters (75 ft-lb)
	U, V, W	3/8-16, Gr. 5	42 Newton-meters (31 ft-lb)
	GND, PE	5/16 Hex	31 Newton-meters (23 ft-lb)
D-Frame	L1 to L6	1/2-13; Gr. 5	100 Newton-meters (75 ft-lb)
	U, V, W	1/2-13; Gr. 5	100 Newton-meters (75 ft-lb)
	GND, PE	1/2 Hex	58 Newton-meters (42 ft-lb)

CHAPTER 6

Installing Output Power Wiring

This chapter provides instructions on wiring output contactors, motor overload protection, and output wiring to the motor.

6.1 Installing Output Contactors (Optional)

Output contactors provide a positive means of disconnecting the motor from the drive. If the application requires the use of output contactors, contact Reliance Electric for assistance.

6.2 Installing Mechanical Motor Overload Protection (Optional)

To provide the motor with overload protection, local, national, and international codes (e.g., NEC/CEC) may require one of the following:

- a motor thermostat be installed internal to the motor
- a mechanical thermal motor overload relay, sized to protect the motor, be installed between the motor and the drive's output terminals.

The Motor Overload Enable parameter (P.040) can be used in place of thermal motor overload relays in single motor applications. Note, however, that temperature measuring devices integral to the motor are the best way to thermally protect AC motors under all conditions. Parameter P.040 must be enabled to provide overload protection. Refer to the LiquiFlo Software Start-Up and Reference manual for more information.

In multiple motor applications (V/Hz regulation only), each motor must have its own user-supplied overload and branch circuit protection.

6.3 Installing Output Wiring from the Drive Output Terminals to the Motor

Important: The total motor lead length must not exceed 76 meters (250 feet).

Use the following steps to connect the AC output power wiring from the drive to the motor:

Step 1. Wire the three-phase AC output power motor leads by routing them as shown in figures 4.1, 4.2, or 4.3. Tables 3.3, 3.4, and 3.5 contain the recommended power wiring sizes.

Do not route more than three sets of motor leads through a single conduit. This will minimize cross-talk that could reduce the effectiveness of noise reduction methods. If more than three drive/motor connections per conduit are required, shielded cable must be used. If possible, each conduit should contain only one set of motor leads.

ATTENTION: Do not route signal and control wiring with power wiring in the same conduit. This can cause interference with drive operation. Failure to observe these precautions could result in damage to, or destruction of, the equipment

ATTENTION: Unused wires in conduit must be grounded at both ends to avoid a possible shock hazard caused by induced voltages. Also, if a drive sharing a conduit is being serviced or installed, all drives using this conduit should be disabled to eliminate the possible shock hazard from cross-coupled motor leads. Failure to observe these precautions could result in bodily injury.

Step 2. Connect the three-phase AC power motor leads to the appropriate output terminals. Figures 4.1, 4.2, and 4.3 show the locations of the output power terminals.

Step 3. Tighten the three-phase AC output power terminals to the proper torque as shown in table 5.1.

CHAPTER 7

Wiring the Regulator Board and RMI Board Terminal Strips

This chapter describes how to wire the Regulator board and RMI board terminal strips for stop, encoder feedback, and remote control signals.

The signals available through the Regulator board terminal strip are shown in tables 7.1 to 7.7 and figures 7.1 and 7.2. Table 7.8 provides additional information.

Note that when the Control Source parameter (P.000) is set to remote (rE), the drive will be controlled by the signals connected to the Regulator board terminal strip. Refer to the LiquiFlo Software Start-Up and Reference manual for more information on how parameter P.000 is used to specify where the drive is controlled from.

Table 7.1 – RS-232 Connections (Terminals 1-3)

Terminal #	Signal
1	Transmit (Tx)
2	Receive (Rx)
3	Regulator Common
Notes: The RS-232 terminals should only be used when the RS-232 communication port (J8) or an Operator Interface Module (OIM) is not being used, as all three devices use the same transmit/receive lines.	

Table 7.2 – Encoder Connections (Terminals 4-9)

Terminal #	Signal
4	+15 VDC
5	Phase A
6	Phase A Not
7	Phase B
8	Phase B Not
9	Regulator Common
Notes: An encoder feedback device must be installed if FVC regulation is used.	

Table 7.3 – Analog Output Connections (Terminals 10 and 11)

Terminal #	Signal
10	Analog Meter Output
11	Regulator Common
Notes: The output of this terminal is either 0-10 VDC or 4-20 mA as determined by the setting of jumper J17 on the Regulator board. The analog output must also be programmed via parameter P.012 for an indication of speed and direction or percent of torque.	

Table 7.4 – Analog Speed/Torque Reference Connections (Terminals 12-15)

Terminal #	Signal
12	Isolated Reference Voltage
13	VDC Speed/Torque Reference
14	mA Speed/Torque Reference
15	Isolated Reference Common
Notes: The analog speed/torque (P.008/U.000) reference is either +/-10 VDC or +/-20 mA, as determined by the setting of jumper J4 on the Regulator board. The analog reference can be adjusted using parameters P.009, P.010, and P.011.	

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Table 7.5 – Digital Input Connections (Terminals 16-25)

Terminal #	Signal
16	+24 VDC (Current Limited) (For remote control digital inputs only)
17	Digital Input 8 (Remote/Local) - Programmable
18	Digital Input 7 (Ramp1/Ramp2) - Programmable
19	Digital Input 6 (Forward/Reverse) - Programmable
20	Function Loss
21	Run/Jog
22	Reset
23	Stop
24	Start
25	+24 VDC Common
Notes: When a user-installed function loss input, a coast-to-stop pushbutton, or another external interlock is installed, the factory-installed jumper connecting terminals 16 and 20 must be removed so that a contact, when open, will stop the drive. Terminals 17, 18, and 19 (remote control inputs 8, 7, and 6) are programmed using parameters P.007, P.008, and P.031 through P.038. Factory default settings are shown here in parentheses. Refer to the LiquiFlo Software Start-Up and Reference manual for more information.	

Table 7.6 – Reserved Connections (Terminals 26 and 27)

Teminal #	Signal
26	No Connection
27	+24 VDC Common
Notes: Terminal 26 has no connection and is not used in LiquiFlo applications. Terminal 27 can be used as a 24 VDC common.	

Table 7.7 – Status Relay Connections (Terminals 28-31)

Terminal #	Signal
28	N.C Relay Contact
29	N.C. Relay Common
30	N.O. Relay Contact
31	N.O. Relay Common
Notes: Relay contact closure is programmable through parameter P.013. Refer to the LiquiFlo Software Start-Up and Reference manual for more information.	

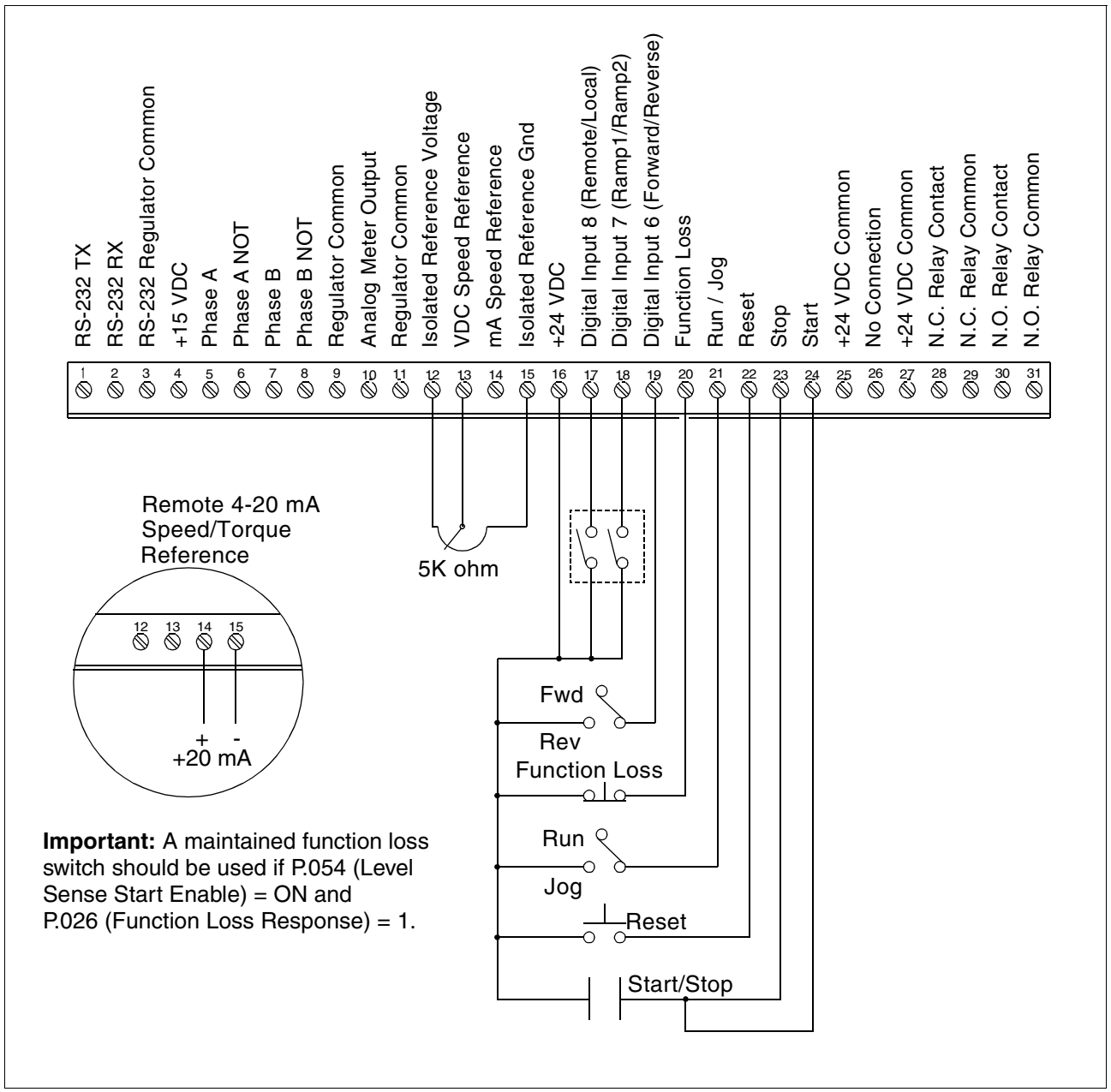


Figure 7.1 – Two-Wire Start/Stop Sample Control Wiring

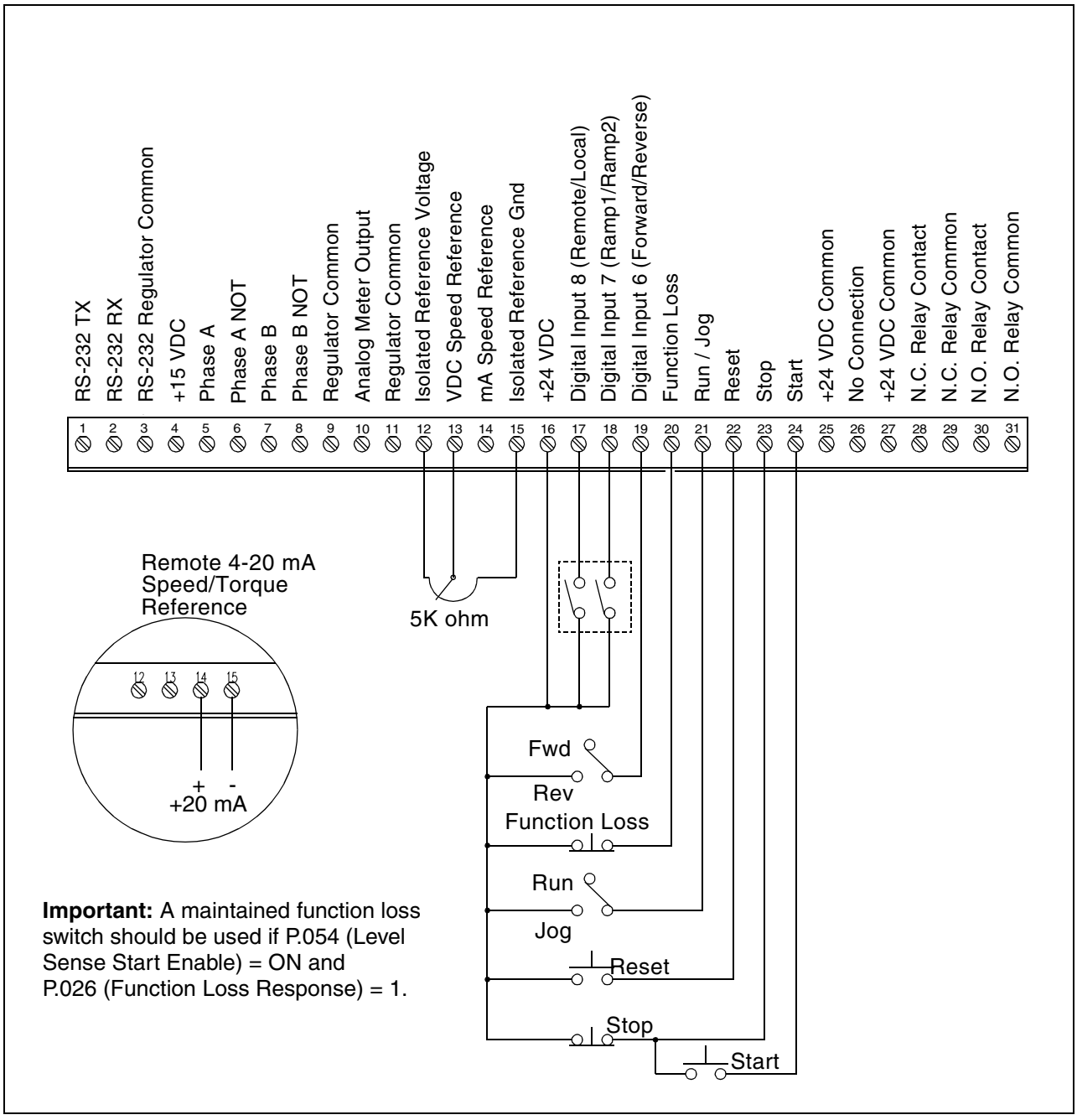


Figure 7.2 – Three-Wire Start/Stop Sample Control Wiring

7.1 Stopping the Drive

ATTENTION: When P.055 is set to ON, the STOP/RESET key is functional only from the selected control source. As a safety precaution, Reliance recommends that an emergency stop push button be located near the drive in an easily accessible location. As a further safety precaution, the user should post a warning on the drive to alert personnel that the STOP/RESET key is not functional. Failure to observe this precaution could result in severe bodily injury or loss of life.

ATTENTION: The user must provide an external, hardwired emergency stop circuit outside of the drive circuitry. This circuit must disable the system in case of improper operation. Uncontrolled machine operation may result if this procedure is not followed. Failure to observe this precaution could result in bodily injury.

Depending upon the requirements of the application, the LiquiFlo drive can be programmed to provide either a coast-to-rest or a ramp-to-rest operational stop without physical separation of the power source from the motor.

A coast-to-rest stop turns off the transistor power device drivers.

A ramp-to-rest stop fires the transistor power device drivers until the motor comes to a stop, and then turns off the power devices.

The user can also program zero speed with power maintained to the motor, but in this condition, the drive is not actually stopped. See the description of terminals 23 and 24 or Stop Type (P.025) for more information on how to program the operational stop.

In addition to the operational stop, the user must provide a hardwired emergency stop external to the drive. The emergency stop circuit must contain only hardwired electromechanical components. Operation of the emergency stop must not depend on electronic logic (hardware or software) or on the communication of commands over an electronic network or link.

Parameter P.055 (STOP/RESET Key Disable) can be used to change the operation of the STOP/RESET key. See the parameter P.055 description in the software manual for more information.

Note that the user-installed hardwired emergency stop may be used at any time to stop the drive.

7.2 Wiring the Encoder Feedback Device (FVC Regulation Only)

If the LiquiFlo drive is programmed to provide FVC regulation, an encoder must be installed. Drives using V/Hz or SVC regulation do not require the use of an encoder feedback device. The encoder connects to terminals 4 to 9 of the regulator's terminal strip:

Terminal	Encoder Connection
4	Supply +15 VDC (250 mA capacity)
5	Phase A Differential Input
6	Phase A Not Differential Input
7	Phase B Differential Input
8	Phase B Not Differential Input
9	Encoder/Regulator Common

Use the following procedure to connect an encoder to the terminal strip:

Step 1. Connect the encoder's wires to terminals 4 through 9 of the terminal strip. See figure 7.3. See table A.6 for additional encoder specifications.

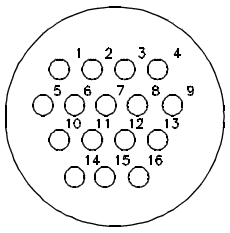
Step 2. Set the following parameters to establish the maximum motor speed:

- P.004: Maximum Speed
- U.001: Encoder PPR
- U.002: Motor Poles
- U.003: Motor Nameplate Base Frequency
- U.005: Motor Nameplate RPM
- U.017: Motor Top Speed

Refer to the LiquiFlo Software Start-Up and Reference manual for more information.

Tamagawa-Style, 16-Pin MS Connector

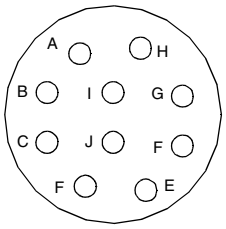
View of Encoder Cable MS Connector (Female)
(M/N 2TC4025 and 2TC4075)



Regulator Terminal Strip		Connector/Cable End	
Terminal 6	WHITE/ORANGE	Pin 1	Phase A
Terminal 5	ORANGE	Pin 2	Phase A Not
Terminal 4	RED	Pin 6	0 VDC
Terminal 9	WHITE/RED	Pin 12	+15 VDC
Terminal 7	BROWN	Pin 8	Phase B
Terminal 8	WHITE/BROWN	Pin 9	Phase B Not

Dynapar-Style, 10-Pin MS Connector

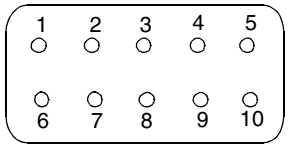
View of Encoder Cable MS Connector (Female)
(M/N 2TC3025 and 2TC3075)



Regulator Terminal Strip		Connector/Cable End	
Terminal 6	WHITE/ORANGE	Pin A	Phase A
Terminal 5	ORANGE	Pin H	Phase A Not
Terminal 4	RED	Pin F	0 VDC
Terminal 9	WHITE/RED	Pin D	+15 VDC
Terminal 7	BROWN	Pin B	Phase B
Terminal 8	WHITE/BROWN	Pin I	Phase B Not

Lakeshore-Style, 10-Pin MS Connector

View of Encoder Cable MS Connector (Female)
(Lakeshore M/N SL56 Slim-Tach Encoder)



Regulator Terminal Strip		Connector/Cable End	
Terminal 6	WHITE/ORANGE	Pin 3	Phase A
Terminal 5	ORANGE	Pin 8	Phase A Not
Terminal 4	RED	Pin 1	0 VDC
Terminal 9	WHITE/RED	Pin 6	+15 VDC
Terminal 7	BROWN	Pin 2	Phase B
Terminal 8	WHITE/BROWN	Pin 7	Phase B Not

Figure 7.3 – Encoder Wiring Connections

7.3 Wiring the Signal and Control I/O

Wire the drive's signal and control I/O to the Regulator board terminal strip as shown in table 7.8.

Table 7.8 – Wiring Signal and Control I/O to the Regulator Board Terminal Strip

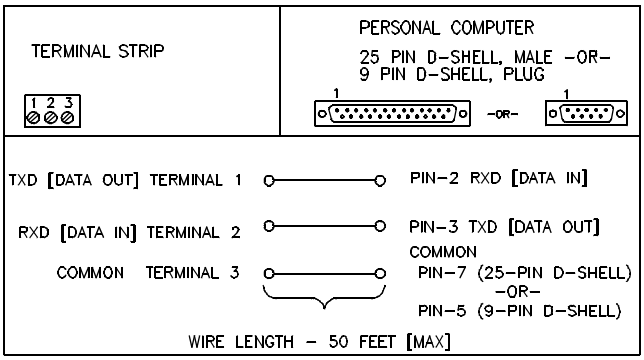
Terminal Number	Description	Parameters/Wiring Connections
Wiring RS-232 Signals		
1 2 3	RS-232 Transmit RS-232 Receive RS-232 Signal/Regulator Common	Note that RS-232 communication between the LiquiFlo drive and a personal computer requires the use of the Control and Configuration (CS3000) software. Refer to instruction manual D2-3348 for more information. These terminals should only be used when the RS-232 port (J8) or an Operator Interface Module (OIM) are not being used, as all three devices use the same transmit/receive lines. 
Wiring Encoder Inputs		
4-9	Encoder Wiring	See section 7.2.

Table 7.8 - Wiring Signal and Control I/O to the Terminal Strip (Continued)

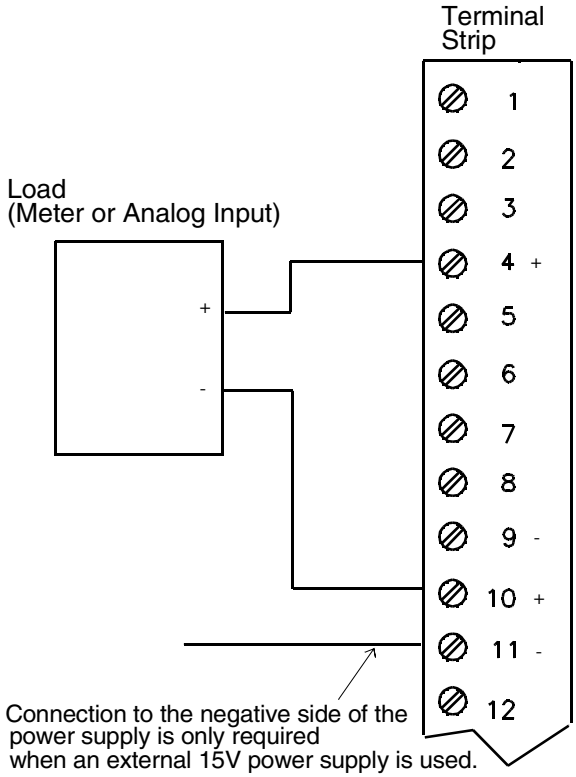
Terminal Number	Description	Parameters/Wiring Connections
	Wiring Analog Outputs	
10 11	0-10 VDC or 4-20 mA Analog Output Reference Regulator Common	The setting of parameter P.012 selects the terminal strip analog output source (either speed or torque). Jumper J17 must also be set. See figure 2.5. The 4-20 mA current selection requires a power supply for operation. The power can be sourced from the encoder supply, terminal 4 (15 VDC), or from an external 15V power supply. Note that the maximum supply current from terminal 4 is 250 mA (encoder and current source) at 15 V. Terminals 9 and 11 are internally connected. 

Table 7.8 - Wiring Signal and Control I/O to the Terminal Strip (Continued)

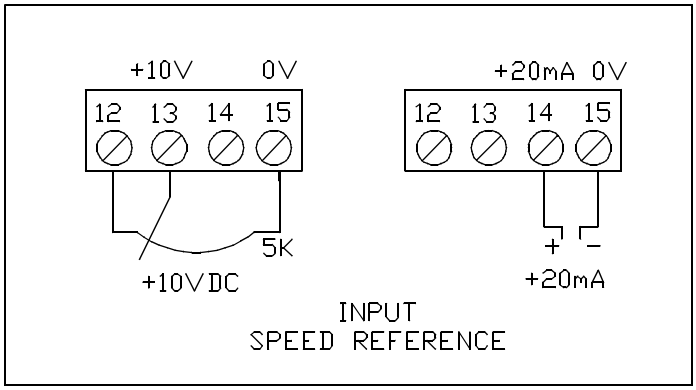
Terminal Number	Description	Parameters/Wiring Connections
Wiring Analog Speed Reference Inputs		
12 13 14 15	Isolated Reference Voltage (+10VDC) Analog Speed/Torque Reference Input Voltage (+/- 10VDC) Analog Speed/Torque Reference Input Current (0-20mA) Isolated Speed/Torque Reference Common (Voltage/Current)	Related parameters: • P.000: Control Source • P.009: Terminal Strip Analog Input Offset • P.010: Terminal Strip Analog Input Gain • P.011: Terminal Strip Analog Input Configure Refer to the LiquiFlo Software Start-Up and Reference manual for additional parameter information. Jumper J4 must also be set. See figure 2.4. 

Table 7.8 - Wiring Signal and Control I/O to the Terminal Strip (Continued)

Terminal Number	Description	Parameters/Wiring Connections
Wiring a Remote/Local Input		
16	+24 VDC Power Supply	Current limited for remote input logic use only.
17	Digital Input 8 (Default - Remote/Local)	Digital input 8 is control function programmable through parameter P.007.
	ATTENTION: If a maintained start contact is used when the control source = rE, switching from local to remote from the terminal strip will cause power to be applied to the motor if the remote start contact is closed. Stay clear of rotating machinery in this case. Failure to observe this precaution could result in bodily injury.	
		The following parameters must be set: • P.000:Control Source (Only active when P.000 = rE) • P.006:Second Menu Password • P.007:Terminal Strip Digital Inputs Configure (Selects and assigns a control function to digital inputs 6 to 8) • P.008:Terminal Strip Speed Reference Source (Analog, Motor Operated Potentiometer (MOP), or Preset Speeds) Note that based on the settings of parameters P.000, P.007, P.008, and r.030 if an RMI board is used, the following parameters can affect digital input 8: • P.023:MOP Accel/Decel Time • P.024:MOP Reset Configuration • P.031 to P.038: Preset Speeds 1-8 Refer to the LiquiFlo Software Start-Up and Reference manual for additional information. Terminal 17 On = Local Control Diagram shows factory setting.

Table 7.8 - Wiring Signal and Control I/O to the Terminal Strip (Continued)

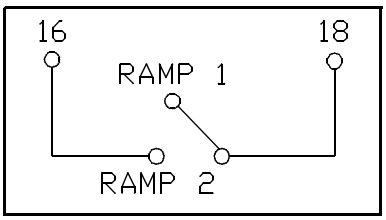
Terminal Number	Description	Parameters/Wiring Connections
Wiring an Additional Ramp Input		
18	Digital Input 7 (Default - Ramp1/Ramp2)	Digital input 7 is control function programmable through parameter P.007. The following parameters must be set: • P.000:Control Source • P.001:Accel Time 1 (Ramp 1) • P.002:Decel Time 1 (Ramp 1) • P.006:Second Menu Password • P.007:Terminal Strip Digital Inputs Configure (Selects and assigns a control function to digital inputs 6 to 8) • P.008:Terminal Strip Speed Reference Source (Analog Motor Operated Potentiometer (MOP), or Preset Speeds) • P.017:Accel Time 2 (Ramp 2) • P.018:Decel Time 2 (Ramp 2) Note that based on the settings of parameters P.000, P.007, P.008, and r.030 if an RMI board is used, the following parameters can affect digital input 7: • P.023:MOP Accel/Decel Time • P.024:MOP Reset Configuration • P.031 to P.038: Preset Speeds 1-8 Refer to the LiquiFlo Software Start-Up and Reference manual for additional information.  Terminal 18 On = Ramp 2 Diagram shows factory setting.

Table 7.8 - Wiring Signal and Control I/O to the Terminal Strip (Continued)

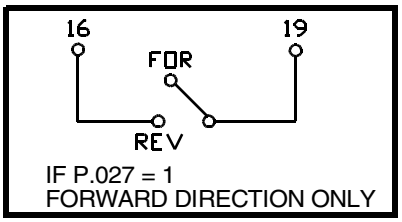
Terminal Number	Description	Parameters/Wiring Connections
Wiring a Forward/Reverse Input		
19	Digital Input 6 (Default - Forward/Reverse)	Digital input 6 is control function programmable through parameter P.007. The following parameters must be set: • P.000:Control Source • P.006:Second Menu Password • P.007:Terminal Strip Digital Inputs Configure (Selects and assigns a control function to digital inputs 6 to 8) • P.008:Terminal Strip Speed Reference Source (Analog, Motor Operated Potentiometer (MOP), or Preset Speeds) • P.027Forward/Reverse Configuration Note that based on the settings of parameters P.000, P.007, P.008, and r.030 if an RMI board is used, the following parameters can affect digital input 6: • P.023:MOP Accel/Decel Time • P.024:MOP Reset Configuration • P.031 to P.038: Preset Speeds 1-8 Refer to the LiquiFlo Software Start-Up and Reference manual for additional information.  Terminal 19 On = Reverse Direction Diagram shows factory setting. From the encoder end of the motor, clockwise rotation indicates forward motor movement.

Table 7.8 - Wiring Signal and Control I/O to the Terminal Strip (Continued)

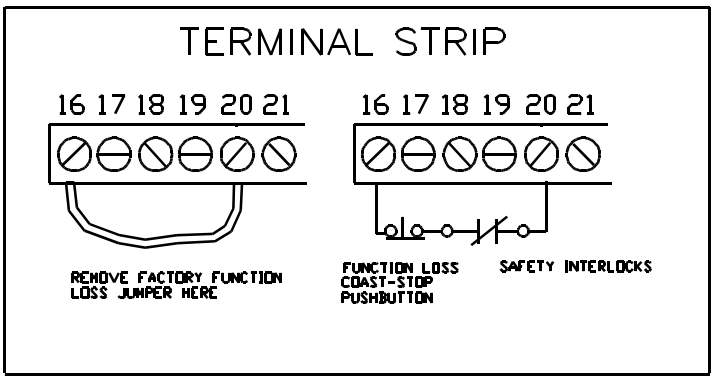
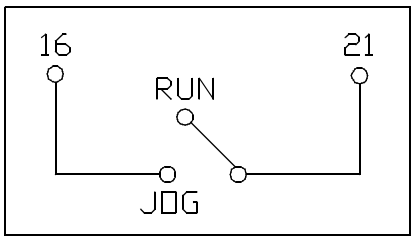
Terminal Number	Description	Parameters/Wiring Connections
		Wiring a Function Loss Input
20	Digital Input 5 (Function Loss)	The following parameters must be set: • P.026:Function Loss Response A signal must be present at terminal 20 for the drive to be able to start. See figures 7.1 and 7.2. The drive is shipped from the factory with a jumper between terminals 16 and 20 which provides the signal. The function loss input should be in series with the drive's external interlocks. In this case, the jumper must be removed before the connections are made. See figure 2.6.  Terminal 20 On = No Function Loss **Important:** A maintained function loss switch should be used if P.054 (Level Sense Start Enable) = ON and P.026 = 1.
		Wiring a Run/Jog Input
21	Digital Input 4 (Run/Jog)	The following parameters must be set: • P.000: Control Source • P.020: Jog Speed Reference • P.021: Jog Ramp Accel Time • P.022: Jog Ramp Decel Time  Terminal 21 On = Jog Operation

Table 7.8 - Wiring Signal and Control I/O to the Terminal Strip (Continued)

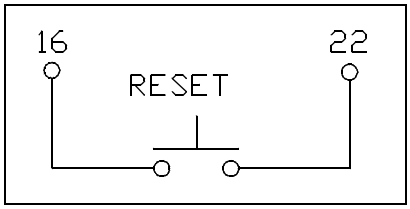
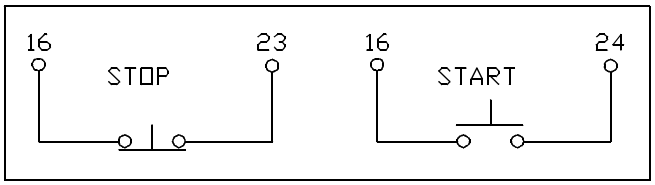
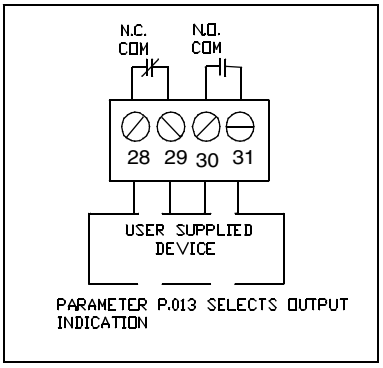
Terminal Number	Description	Parameters/Wiring Connections
Wiring the Reset Input		
22	Digital Input 3 (Reset)	The following parameter must be set: • P.000: Control Source  Terminal 22 On = Reset
Wiring the Stop/Start Inputs		
23 24	Digital Input 2 (Stop) Digital Input 1 (Start)	The following parameter must be set: • P.000: Control Source • P.025: Stop Type  Terminal 23 Off = Stop Terminal 24 On Transition = Start
25	24 VDC Isolated Common	
Reserved Teminals		
26 27	No Connection +24 VDC Isolated Common	Terminal 26 has no connection and is not used in LiquiFlo applications. Terminal 27 can be used as a 24V DC common.

Table 7.8 - Wiring Signal and Control I/O to the Terminal Strip (Continued)

Terminal Number	Description	Parameters/Wiring Connections
Wiring the Output Status Relays		
28	Normally-Closed Contact (Form B)	Both Form A and Form B contacts are rated for 250 VAC/ 30 VDC at 5 amps resistive or 2 amps inductive load.
29	Normally-Closed Contact Common (Form B)	The following parameter must be set: • P.013: Output Relay Configuration
30	Normally-Open Contact (Form A)	Note that depending on the setting of parameter P.013, the relay coil will energize (the normally-open contact will close and the normally-closed contact will open). Refer to the LiquiFlo Software Start-Up and Reference manual for more information.
31	Normally-Open Contact Common (Form A)	

7.4 Wiring the RMI Board Terminal Strip

ATTENTION: You are responsible for conforming with all applicable local, national, and international codes. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Refer to figure 7.4 for the signal and control I/O terminal connections on the RMI board. Table 7.9 describes terminal strip connections and related parameters. Refer to the RMI board instruction manual (D2-3341) for parameter descriptions.

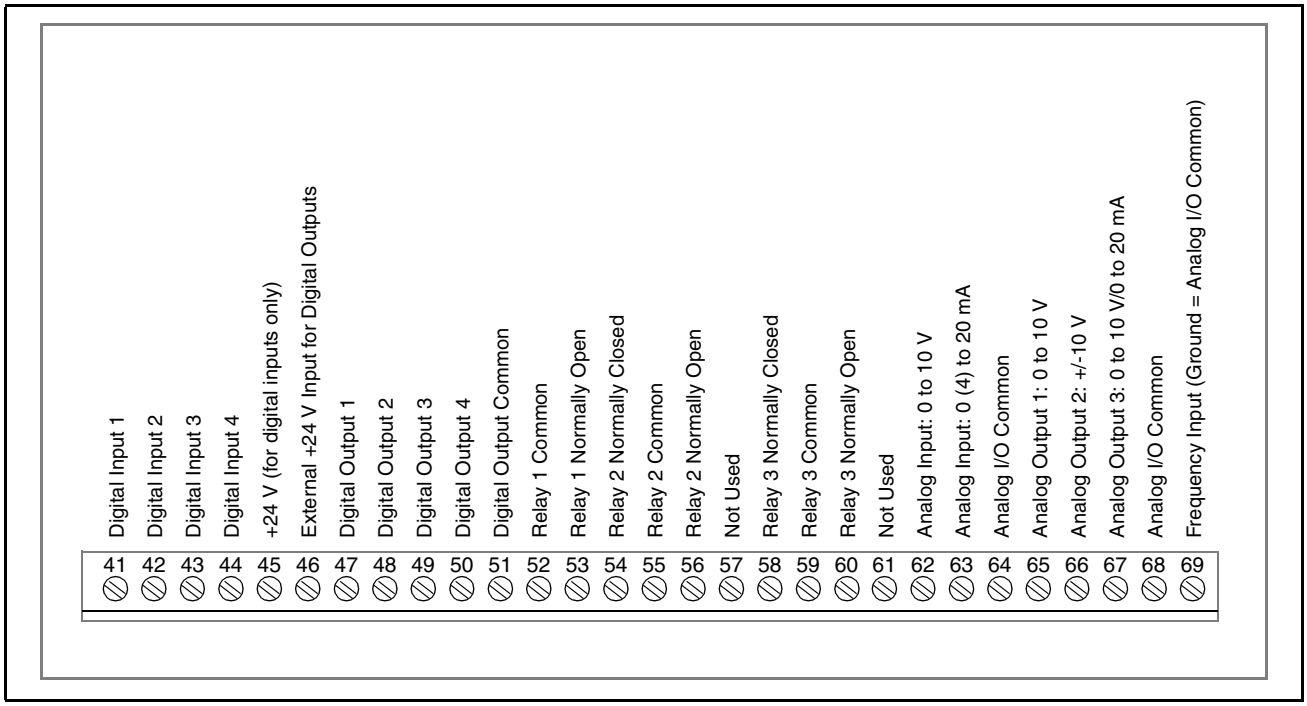

41 Digital Input 1
42 Digital Input 2
43 Digital Input 3
44 Digital Input 4
45 +24 V (for digital inputs only)
46 External +24 V Input for Digital Outputs
47 Digital Output 1
48 Digital Output 2
49 Digital Output 3
50 Digital Output 4
51 Digital Output Common
52 Relay 1 Common
53 Relay 1 Normally Open
54 Relay 2 Normally Closed
55 Relay 2 Common
56 Relay 2 Normally Open
57 Not Used
58 Relay 3 Normally Closed
59 Relay 3 Common
60 Relay 3 Normally Open
61 Not Used
62 Analog Input: 0 to 10 V
63 Analog Input: 0 (4) to 20 mA
64 Analog I/O Common
65 Analog Output 1: 0 to 10 V
66 Analog Output 2: +/-10 V
67 Analog Output 3: 0 to 10 V/0 to 20 mA
68 Analog I/O Common
69 Frequency Input (Ground = Analog I/O Common)

Figure 7.4 – Terminal Connections on the RMI Board

Table 7.9 – Wiring Signal and Control I/O to the RMI Board Terminal Strip

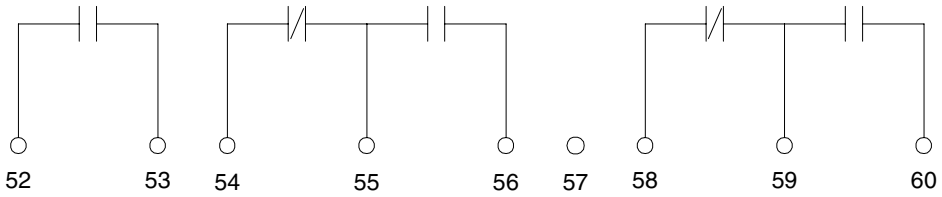
Terminal Number	Description	Related Parameters, Specifications, and Jumpers
Digital Inputs, Control Voltage Output		
41 42 43 44	Digital Input 1 Digital Input 2 Digital Input 3 Digital Input 4	The four digital inputs are configured using parameter r.030.
45	+24 VDC Supply, Control Voltage Output	Current-limited and isolated. This supply should not be used as an external supply for anything other than the four digital inputs.
46	24 VDC Supply, Control Voltage Input	100 mA per output with an external power supply. Jumper 24 V EXT
47 48 49 50	Digital Output 1 Digital Output 2 Digital Output 3 Digital Output 4	Configuration: r.031 Timer: r.040 Configuration: r.032 Timer: r.041 Configuration: r.033 Timer: r.042 Configuration: r.034 Timer: r.043 20 mA per output with jumper set to 24 V INT
51	Common	Digital I/O common
Relay Outputs  		
Relay 1		
52 53	Common Normally Open Contact	Configuration: r.035 Timer: r.044
Relay 2		
54 55 56	Normally Closed Contact Common Normally Open Contact	Configuration: r.036 Timer: r.045
Relay 3		
58 59 60	Normally Closed Contact Common Normally Open Contact	Configuration: r.037 Timer: r.046
Analog Inputs, Frequency Input		
62	Voltage Signal Input	+10 VDC supply, isolated, stabilized, max. 2.7 mA; jumper setting: V IN (default)
63	Current Signal Input	0 to 20 mA Analog current speed reference input; jumper setting: C IN
69	Frequency Input	0 to 200 kHz
64	Analog I/O Common	Isolated common for voltage/current or frequency input.

Table 7.9 – Wiring Signal and Control I/O to the RMI Board Terminal Strip (Continued)

Terminal Number	Description	Related Parameters, Specifications, and Jumpers
Analog Outputs		
65	Analog Output No. 1 0 to 10 VDC	Configuration: r.001 Offset: r.002 Gain: r.003
66	Analog Output No. 2 –10 to +10 VDC	Configuration: r.004 Offset: r.005 Gain: r.006
67	Analog Output No. 3 V OUT: 0 to 10 VDC C OUT: 0 to 20 mA	Configuration: r.007 Offset: r.008 Gain: r.009
68	Analog Common	Common for all analog outputs.

Terminals 57 and 61 are not used.

CHAPTER 8

Completing the Installation

This chapter provides instructions on how to perform a final check of the installation before power is applied to the drive.

> **ATTENTION:** Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should start and adjust it. Read and understand this manual in its entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

8.1 Checking the Installation

Use the following procedure to verify the condition of the installation:

> **ATTENTION:** DC bus capacitors retain hazardous voltages after input power has been disconnected. After disconnecting input power, wait five (5) minutes for the DC bus capacitors to discharge and then check the voltage with a voltmeter to ensure the DC bus capacitors are discharged before touching any internal components. Failure to observe this precaution could result in severe bodily injury or loss of life.

Step 1. Turn off, lock out, and tag the input power to the drive. Wait five minutes.

Step 2. Verify that the DC bus voltage is zero. Refer to section 9.3.

Step 3. If a function loss coast-stop pushbutton has been installed, verify that it has been wired correctly. Be sure the factory-installed jumper at terminals 16 and 20 has been removed so that the coast-stop pushbutton will work.

> **ATTENTION:** The user must provide an external, hardwired emergency stop circuit outside of the drive circuitry. This circuit must disable the system in case of improper operation. Uncontrolled machine operation may result if this procedure is not followed. Failure to observe this precaution could result in bodily injury.

Step 4. Remove any debris, such as metal shavings, from around the drive.

Step 5. Check that there is adequate clearance around the drive.

Step 6. Verify that the wiring to the terminal strip and the power terminals is correct.

Step 7. Check that the wire size is within terminal specifications and that the wires are tightened properly.

Step 8. Check that user-supplied branch circuit protection is installed and correctly rated.

Step 9. Check that the incoming power is rated correctly.

Step 10. Check the motor installation and length of motor leads.

Step 11. Disconnect any power correction capacitors connected between the drive and the motor.

Step 12. Check that the rating of the transformer (if used) matches the drive requirements and is connected properly.

Step 13. Verify that a properly-sized ground wire is installed and a suitable earth ground is used. Check for and eliminate any grounds between the motor frame and the motor power leads. Verify that all ground leads are unbroken.

Step 14. Visually inspect the liquid-cooling connections for leaks.

Step 15. Uncouple the motor from any driven machinery to initially start the drive.

8.2 Powering Up After Installation Is Complete

Use the following procedure to verify that the drive is installed correctly and is receiving the proper line voltage:

Step 1. Turn the drive's input power disconnect to the On position.

Step 2. Turn coolant on.

Step 3. Apply power to the drive.

Step 4. Follow the start-up procedure in the LiquiFlo Software Start-Up and Reference manual.

CHAPTER 9
Troubleshooting the Drive

This chapter describes how to troubleshoot the drive and the equipment that is needed to do so. Also provided are replacement part lists and information on clearing faults.

9.1 Test Equipment Needed To Troubleshoot

An isolated multimeter will be needed to measure DC bus voltage and to make resistance checks. Note that dedicated troubleshooting test points are not provided.

9.2 Drive Alarms and Faults

The drive will display alarm and fault codes to assist in troubleshooting when a problem develops during self-tuning or drive operation.

If an alarm condition occurs, the drive will continue to run and a 2- or 3-digit alarm code will flash on the display.

If a fault occurs, the drive will coast to rest and a 2- or 3-digit fault code will flash on the display.

Refer to the LiquiFlo Software Start-Up and Reference manual for more information on drive alarms and faults.

9.3 Verifying That DC Bus Capacitors Are Discharged

ATTENTION: DC bus capacitors retain hazardous voltages after input power has been disconnected. After disconnecting input power, wait five (5) minutes for the DC bus capacitors to discharge and then check the voltage with a voltmeter to ensure the DC bus capacitors are discharged before touching any internal components. Failure to observe this precaution could result in severe bodily injury or loss of life.

The LiquiFlo drive's DC bus capacitors retain hazardous voltages after input power has been disconnected. Perform the following steps before touching any internal components:

Step 1. Turn off and lock out input power. Wait five minutes.

Step 2. Verify that there is no voltage at the drive's input power terminals.

Step 3. Measure the DC bus potential with a voltmeter while standing on a non-conductive surface and wearing insulated gloves (1000 V).

Measure the DC bus potential at the test points on the Power Module Interface board. See figure 9.1 for B-frame drives, figure 9.2 for C-frame drives, or figure 9.3 for D-frame drives. For additional wiring information, refer to Appendix C, Appendix D, or Appendix E.

Step 4. Once the drive has been serviced, reapply input power.

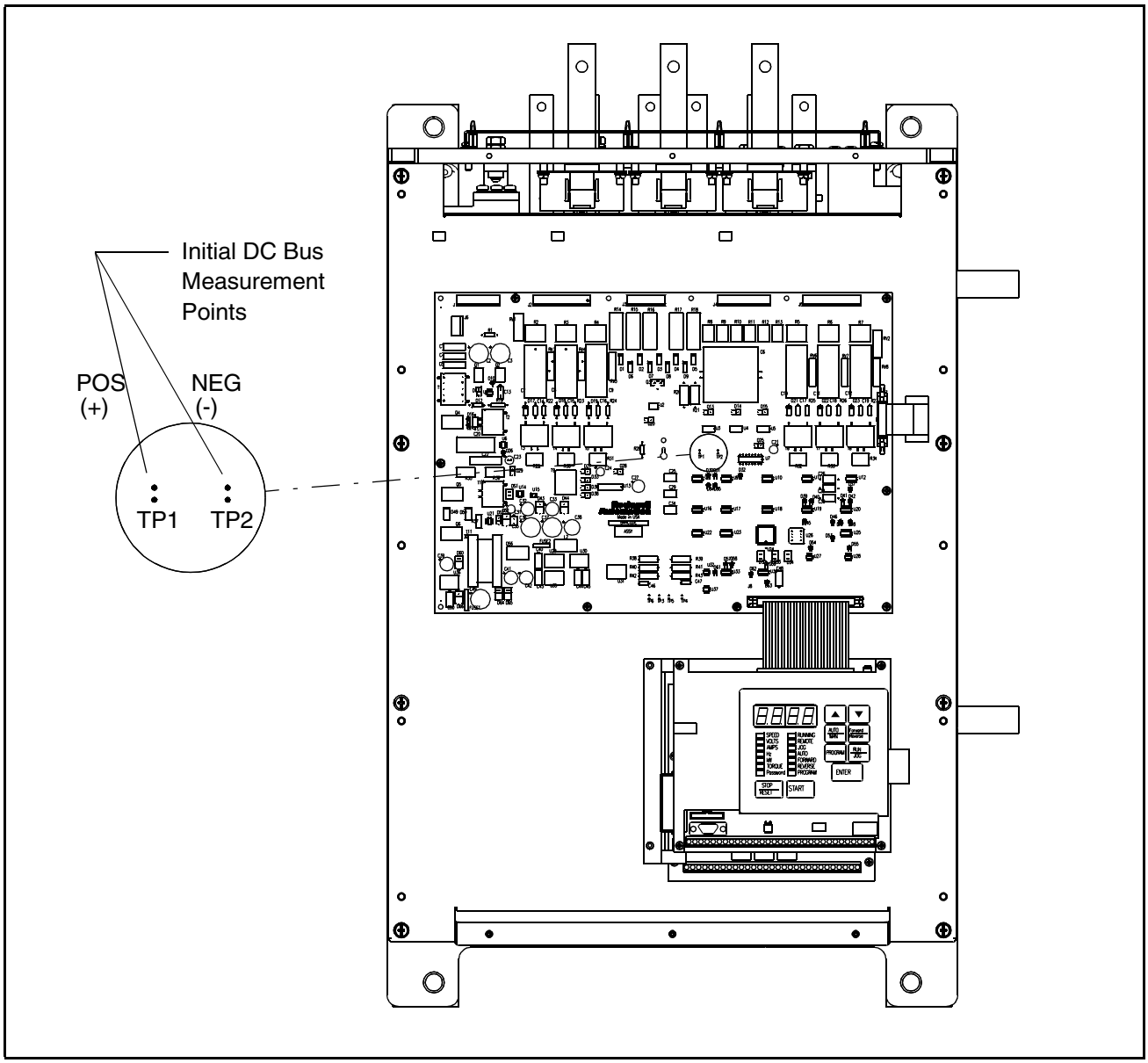


Figure 9.1 – DC Bus Voltage Terminals (B-Frame Drives)

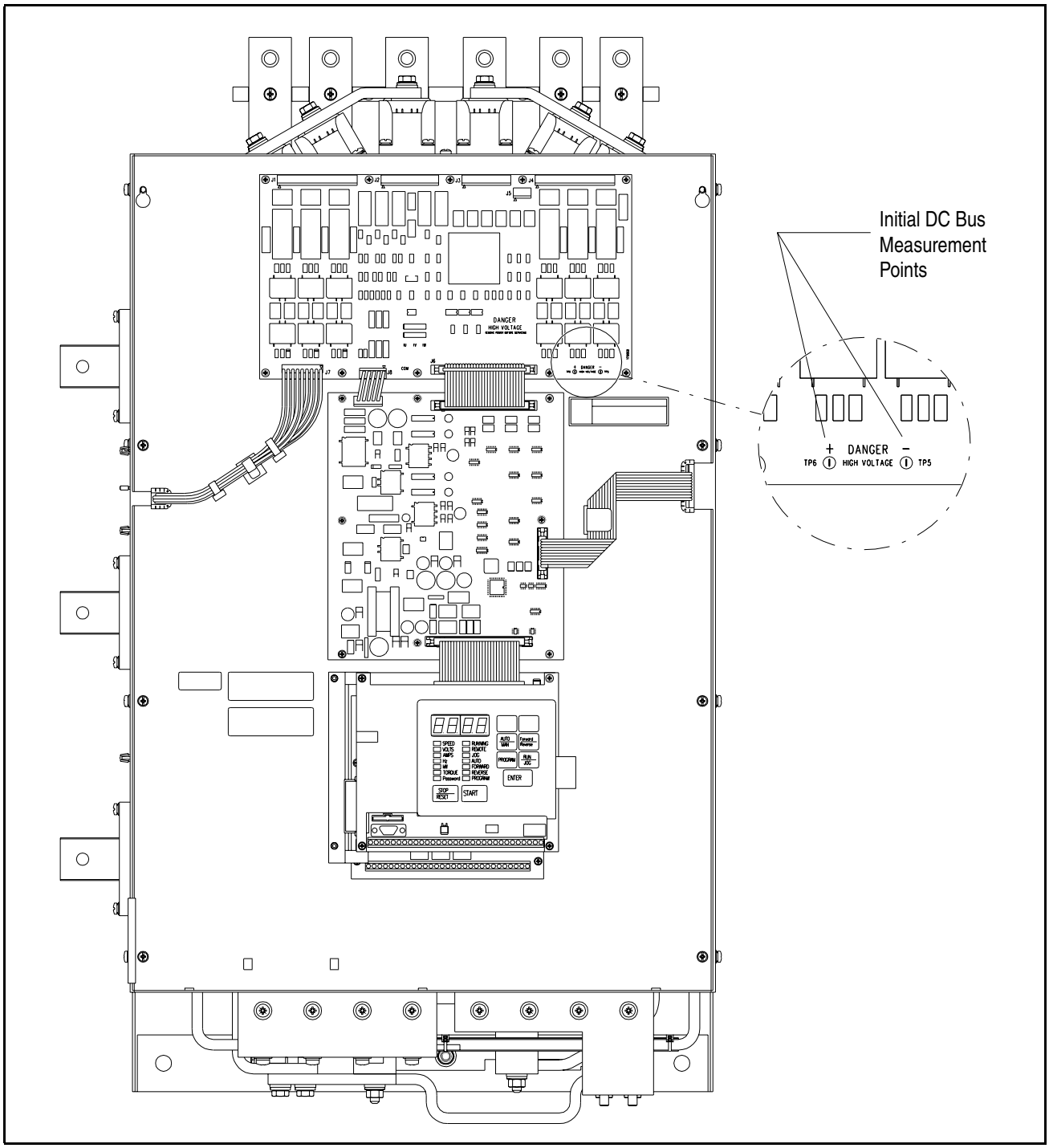


Figure 9.2 – DC Bus Voltage Terminals (C-Frame Drives)

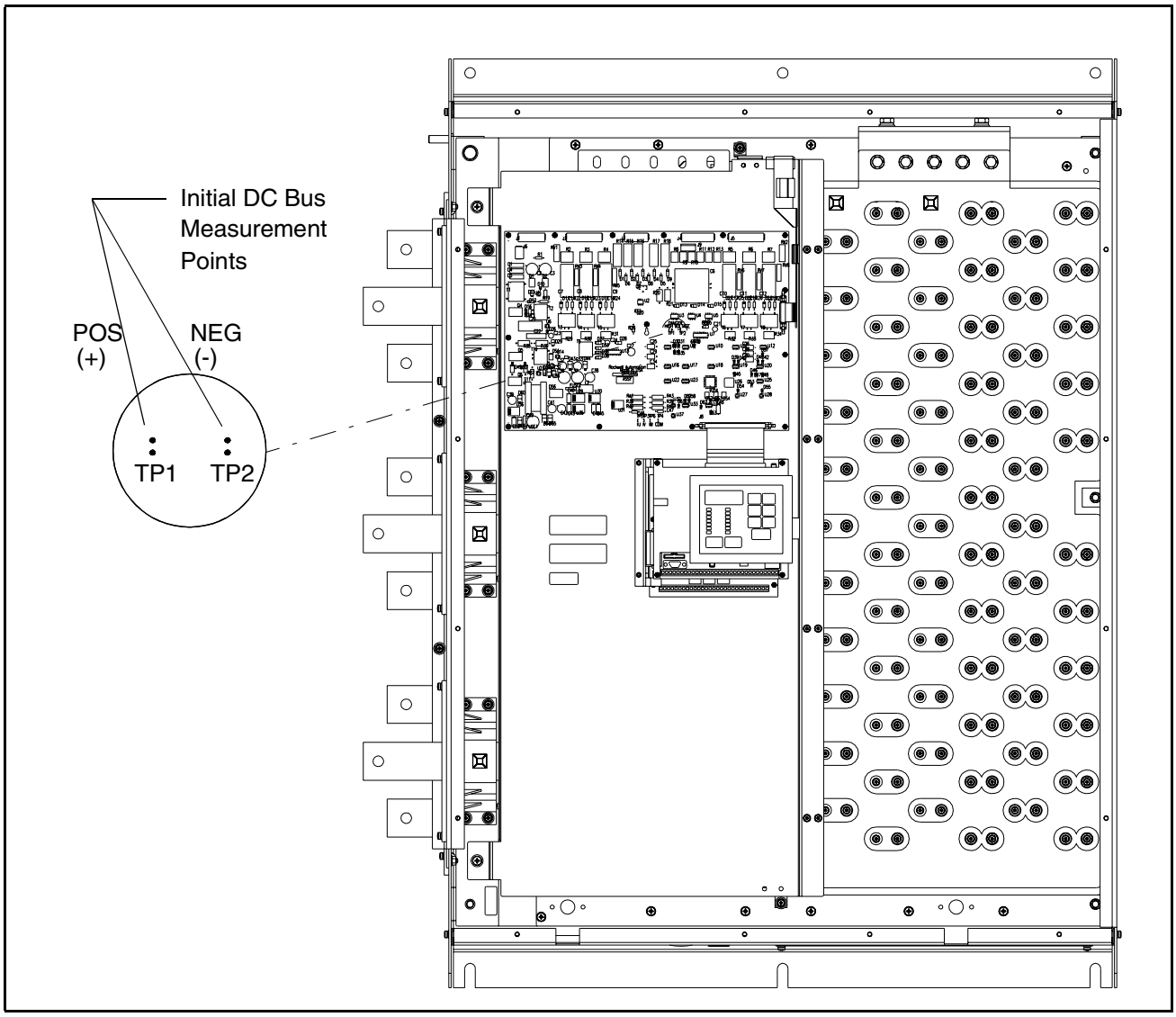


Figure 9.3 – DC Bus Voltage Terminals (D-Frame Drives)

9.4 Checking the Power Modules with Input Power Off

Use the following procedure to check the drive's Power Module circuitry with power off:

ATTENTION: DC bus capacitors retain hazardous voltages after input power has been disconnected. After disconnecting input power, wait five (5) minutes for the DC bus capacitors to discharge and then check the voltage with a voltmeter to ensure the DC bus capacitors are discharged before touching any internal components. Failure to observe this precaution could result in severe bodily injury or loss of life.

Step 1. Turn off and lock out input power. Wait five minutes.

Step 2. Verify that there is no voltage at the drive's input power terminals.

Step 3. Check the DC bus potential with a voltmeter as described in section 9.3 to ensure that the DC bus capacitors are discharged.

Step 4. Disconnect the motor from the drive.

Step 5. Check all AC line and DC bus fuses.

Step 6. If a fuse is open, use a multimeter to check the input diodes and output IGBTs. See table 9.1.

Step 7. Reconnect the motor to the drive.

Step 8. Reapply input power.

Table 9.1 – Resistance Checks

Input Diode No.	Meter Connection (+)	(-)	Component is OK if resistance (R) is:	Component is defective if:
1	*	L1	10 < R < 1 megohm	Continuity (short circuit) or open when the meter is connected with reversed polarity.
2	*	L2		
3	*	L3		
4	*	L4		
5	*	L5		
6	*	L6		
7	L1	**		
8	L2	**		
9	L3	**		
10	L4	**		
11	L5	**		
12	L6	**		

* (+) DC Bus Volts power terminal
** (-) DC Bus Volts power terminal

Table 9.1 - Resistance Checks (Continued)

IGBT No.	Meter Connection (+)	(-)	Component is OK if resistance (R) is:	Component is defective if:
1	*	W/T3	10 < R < 1 megohm	Continuity (short circuit) or open when the meter is connected with reversed polarity.
2	*	V/T2		
3	*	U/T1		
4	W/T3	**		
5	V/T2	**		
6	U/T1	**		

* (+) DC Bus Volts power terminal
** (-) DC Bus Volts power terminal

9.5 Replacement Parts

Tables 9.2, 9.3, and 9.4 list the replacement parts that are available from Reliance Electric. See figures 2.2, 2.3, and 2.4 for the location of the parts.

Table 9.2 – B-Frame LiquiFlo Drive Replacement Parts

Description	Part Number	Quantity
		M/N 41L4060 M/N 41LR4060
350 HP Power Module Control (PMC) Printed Circuit Board	179170	1
Gate Driver PCB	179168	1
Membrane Switch Keypad/Bracket	410483-15B	1
Regulator PCB	179116	1
Remote Meter Interface (RMI) PCB	814.56.00	1
Current Feedback Devices	25503-012-03	3
LEM Harness	179215	1
Laminate Harness	179216	1
Chillplate Harness	342435-C01	1
SCR Gate Harness	179218	1
Internal Fan	179196	1

Table 9.3 – C-Frame LiquiFlo Drive Replacement Parts

Description	Part Number	Quantity	
		M/N 50LW4060 M/N 50LR4060	M/N 64LW4060 M/N 64LR4060
450 HP Power Module Adapter (PMA) Printed Circuit Board (PCB)	179134	1	—
600 HP Power Module Adapter (PMA) Printed Circuit Board (PCB)	179067	—	1
DC Bus Control PCB	179069	1	1
Gate Driver PCB	179065	2	2
Membrane Switch Keypad/Bracket	410483-15B	1	1
Regulator PCB	179116	1	1
Remote Meter Interface (RMI) PCB	814.56.00	1	1
Current Feedback Devices	25503-011-01	3	3
SCR Module	22501-025-04	6	6
Bus/Gate Driver Interface Harness	179055	1	1
Gate Driver Jumper Harness	179056	1	1
Bus/PMA Interface Harness	179057	1	1
Power Interface Harness	179058	1	1
SCR (S1, S2, S3) Gate Interface Harness	179059	1	1
SCR (S4, S5, S6) Gate Interface Harness	179060	1	1
LEM Interface Harness	179061	1	1
Laminate PMA Interface Harness	179062	1	1
Chillplate Interface Harness	342410-C01	1	1
Internal Fan Assembly (user-supplied)	*	1	1

* Comair - Rotron M/N P2TB3 or equivalent.

Table 9.4 – D-Frame LiquiFlo Drive Replacement Parts

Description	Part Number	Quantity
		M/N 120L4060
1000 HP Power Module Control (PMC) Printed Circuit Board	179452	1
Gate Driver PCB	179355	3
Membrane Switch Keypad/Bracket	410483-15B	1
Regulator PCB	179116	1
Remote Meter Interface (RMI) PCB	814.56.00	1
Current Feedback Devices (LEM)	179357	3
LEM Harness	179447	1
Gate Drive Control Harness	179448	1
Chillplate Harness	342702-C01	1
Gate Drive Power Harness	179449	1
Internal Fan	179196	2

APPENDIX A

Technical Specifications

Table A.1 – Service Conditions

AC Line Distribution System Capacity (maximum) for 460 VAC Units	85,000 amps symmetrical fault current capacity. Short circuit rating may be limited to 65,000 amps if a circuit breaker is used instead of fuses.
Control Method	All-digital vector, sinusoidal pulse-width-modulated (PWM)
Displacement Power Factor	0.96
Line Frequency	50/60Hz (±2 Hz)
Line Voltage Variation	-10% to +10%
Line Dip Ride-Through	FVC: Maximum 500 milliseconds V/Hz, SVC: Adjustable up to 999.9 seconds (See P.042)
Motor Lead Lengths	76 meters (250 feet) total
Remote Operator Control Wire Length	Up to 303 meters (1000 feet) from the drive
Analog Speed Reference Resolution	1/1024 (10 bits) 0.1%
Acceleration Adjustment Range	0.1 to 999.9 seconds (within the ability of current)
Carrier Frequency	2 kHz, 4 kHz. or 8 kHz (software-selectable)
Current Limit Adjustment	Vector: U.006 to 150% (based on motor nameplate rating) V/Hz: 50% to 110% (based on drive nameplate rating)
Service Factor	1.0
Speed Adjustable Range	From 0 RPM to maximum speed (vector)
Speed Regulation	Vector: 0.01% FVC, 0.5% SVC (steady state) V/Hz: Motor slip dependent
Speed Reference Resolution	1 RPM with local keypad, -4095 to +4095 counts with a network or serial reference
Torque Control Response	180 to 220 Hz
Torque Linearity	+3% with optimal parameter setting (typical) (see parameter U.005)

Table A.2 – Environmental Conditions

Condition	Specification
Operating Temperature (inside an enclosure)	0°C to 55°C* (32°F to 131°F)
Storage Temperature (Ambient)	-40°C to 65°C (–40°F to 149°F)
Humidity	5% to 95% (non-condensing)

*User-supplied cabinet air cooling system must provide adequate heat dissipation to maintain an internal temperature not to exceed 55°C. Refer to table 2.1 for drive air watts loss.

Table A.3 – Terminal Strip Input Specifications

Signal Type	Terminal(s)	Specification
Speed Reference Input	12-15	10 V (@ 50 K ohm input impedance or 20 mA)
Digital Inputs (1 - 8)	16	+24 VDC Isolated Supply
	17	Remote/Local (Default)
	18	Ramp1/Ramp2 (Default)
	19	Forward/Reverse (Default)
	20	Function Loss
	21	Run/Jog
	22	Reset
	23	Stop
	24	Start

Table A.4 – Terminal Strip Output Specifications

Signal Type	Terminal(s)	Specification
Analog Output	10 -11 scaled signal	0-10 VDC or 4-20 mA
No Connection	26	There is no connection to terminal 26.
Common	27	+24 VDC common

Table A.5 – Terminal Strip RS-232 Specifications

Signal Type	Terminal(s)	Specification
RS-232 Communications	1	XMIT
	2	RECV
	3	COMMON

Table A.6 – Encoder Feedback Device Specifications (FVC Regulation Only)

Specification	Rating
Motor Poles	2, 4, 6, or 8 poles
Overcurrent IET	200% load (based on drive nameplate rating)
Overload Current Rating	150% for 5 seconds
Speed Control Range	1:600 with 1024 PPR
Speed Control Response	15 Hz (typical)
Encoder Feedback	15 V differential quadrature, encoder incremental (512 PPR, 1024 PPR, 2048 PPR, 4096 PPR)
Service Factor	1.0

Table A.7 – Input Signal Response Times (Maximum)

Signal Type and Source	Volts/Hertz Regulation*	Vector Regulation*
Keypad START	150 milliseconds	130 milliseconds
Terminal Strip:		
START	126 milliseconds	105 milliseconds
STOP, RESET, FL	75 milliseconds	75 milliseconds
Preset Speeds	75 milliseconds	75 milliseconds
Analog Speed/Trim Reference	16 milliseconds	5 milliseconds
Analog Torque Reference	N/A	0.5 milliseconds
Network:		
START	46 milliseconds + network transport time	25 milliseconds + network transport time
STOP, RESET, FL	26 milliseconds + network transport time	25 milliseconds + network transport time
Analog Speed/Trim Reference	5 milliseconds + network transport time	5 milliseconds + network transport time
Torque Reference	N/A	0.5 milliseconds + network transport time

*These are the maximum times from transitioning the input to the drive reacting to the input.

APPENDIX B

Cooling System Specifications

	M/N 41L4060	M/N 41LR4060	M/N 50LW4060 M/N 64LW4060	M/N 50LR4060 M/N 64LR4060	M/N 120L4060
Coolant Type	Potable water with no additives.	Refrigerant	Potable water with no additives.	Refrigerant	Potable water with approved corrosion inhibitor[1].
Inlet Coolant Temperature Range	15°C to 40°C (60°F to 104°F)[2]	See note[3].	15°C to 40°C (60°F to 104°F)[2]	See note[3].	15°C to 40°C (60°F to 104°F)[2]
Minimum Coolant Flow Rate at Full Load	7.0 gpm	See note[3].	5.0 gpm	See note[3].	8.0 gpm
Differential Coolant Pressure at Minimum Flow Rate	3.0 psi	See note[3].	34.0 psi	See note[3].	5.0 psi
Maximum Inlet Pressure	450 psi	See note[3].	300 psi	See note[3].	50 psi
Maximum Heat Load	16,000 BTU/hour	16,000 BTU/Hour	25,000 BTU/hour	25,000 BTU/Hour	40,000 BTU/hour

[1]Approved corrosion inhibitor: Chemtool, Inc., Crystal Lake, IL., part number CT787-C. Concentration is 2% by volume.

[2]Coolant temperature should be greater than the dew point of the surrounding air to prevent condensation on the tubing and heatsink.

[3]Contact Reliance Electric for coolant circuit requirements.

APPENDIX C

B-Frame LiquiFlo Drive Wiring Diagrams

Replace with file C.fm (17 x 11, z-fold).

APPENDIX D

C-Frame LiquiFlo Drive Wiring Diagrams

Replace with file D.fm (17 x 11, z-fold).

APPENDIX E

D-Frame LiquiFlo Drive Wiring Diagrams

Replace with file E.fm (17 x 11, z-fold).

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